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THE NICARAGUA CANAL COMMISSION, through Rear Admiral J. G. Walker, U. S. N., Chairman of the Commission, asks that Congress appropriate an additional $100,000 for the continuance of surveys by the Commission in Nicaragua. Admiral Walker says that a large amount of money has already been expended in bringing to the work about one hundred engineers and in securing native laborers. The expense of maintaining and transporting this staff is large; and now that the working party is on the ground he thinks it would be wise to provide the means for continuing the surveys to an intelligent and complete end. From other sources the division of parties is noted as follows: Mr. E. S. Wheeler has general charge of the surveys; Lieut. G. C. Harms, U. S. N., is in charge of soundings in the San Juan River and Lake Nicaragua; Mr. Geo. Brown is running a shore line along the banks of the San Juan, and establishing levels and bank topography; diamond drill borings are to be made at various points; Commander Tilley, of the "Newport," is in charge of the offshore hydrography in connection with the proposed harbor on the Atlantic side; Commander Richards, of the "Alert," is doing similar work on the Pacific side, at Brito. Separate parties are at work on the lock sites, on the division between Ochoa and the Atlantic, and that from Lake Nicaragua to the Pacific. Two parties are running exact levels, and the whole center-line is being re-run and cross-sectioned for preliminary estimates.

THE PROPOSED HOUSTON, TEXAS, SHIP CANAL, a survey of which was ordered by the last Congress, is reported upon as follows by Gen. John M. Wilson, Chief of Engineers, U. S. A.: The proposed ship canal would commence at Galveston and cross Galveston Bay with a channel, 150 ft. wide and 25 ft. deep. From the mouth of the San Jacinto River to Buffalo Bayou the channel would be 100 ft. wide; and the canal up this bayou to Houston would have the same width, with a 25-ft. depth throughout. At Houston would be a harbor 500 ft. wide. The total length of the canal would be 58¾ miles, and the total estimated cost is $4,000,000; the estimated annual maintenance cost is $100,000. The Chief of Engineers, and board of engineers reporting, are of the opinion that the interests involved would justify the proposed expenditure. An estimate is submitted showing a possible annual saving of $900,000 in the transportation cost of cotton alone by this water route.

THE LEASING OR SALE OF NEW YORK STATE canals to the United States Government is permitted by an amendment to the New York Constitution offered in the New York Senate by Senator Pavey. A considerable number of the Senators and Assemblymen have expressed themselves in favor of the measure. At Washington a joint resolution has been introduced in the House by Representative Mahany providing that the United States shall enter into negotiations with New York for the purchase or lease of the Erie Canal.

THE PHILADELPHIA HARBOR IMPROVEMENT has been completed and the city has been officially notified of that fact by Major C. W. Raymond, Engineer Corps U. S. A., the officer in charge. Generally described, the work performed is as follows: A 26-ft. channel at low water, 1,000 ft. wide, extending from the Pennsylvania R. R. bridge at Bridesburg to Kaighn's Point, a distance of a little more than six miles. From the lower end of Petty Island, along the entire Philadelphia river front, there is a depth of water of 30 ft. for a width of from 400 to 600 ft. To the Camden shore there is for a distance of about 1,000 ft. beyond the eastern edge of the new 1,000-ft. channel a depth decreasing from 26 to 12 ft. In this improvement Smith's and Windmill islands, formerly in front of the city, have been entirely removed, and a slice of 100 acres has been taken off Petty's Island. The total cost of the improvement is $4,343,652; including $708,652 paid for the islands taken. The total of material removed was 21,005,061 cu. yds.; of this 3,585,018 cu. yds. were deposited on League Island, raising an area of 147 acres 12 ft. above low water; and 3,221,191 cu. yds. were placed on Petty Island, raising 347 acres 10 ft. above low water. The remainder was dumped into secondary channels of the river. Work upon the improvement was commenced in 1891, by James A. Mundy & Co., and under this contract 805,712 cu. yds. were taken out. This contract was annulled for too slow progress on Dec. 23, 1892, and the second contract was let to the American Dredging Co., on June 1, 1893, at 14.2 cts. per cu. yd.; and this latter company completed the work.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision between two Lehigh Valley R. R. locomotives in Buffalo, N. Y. Jan. 10. A passenger locomotive was backing in on the main track and ran into the tender of a yard engine either standing still or moving slowly. Two switchmen standing on the tail board of the yard engine were so badly injured that they died in a short time.

FIRE DESTROYED THE TIMBER LINING of the Fairview Tunnel, on the Santa Fe Pacific R. R., about 9 miles west of Williams, Ariz., on Jan. 18. Sparks from an engine are supposed to have ignited the timbers, and in a short time the entire tunnel was in flames. Two men were fatally injured by falling rock and burning timbers while fighting the fire. Passengers are being transferred around the mountain, as no trains can run through for several days.

A TORNADO BURST over Fort Smith, Ark., Jan. 11, and according to reports 40 persons were killed and many others seriously injured. The damage to property is figured at about $1,000,000.

AN EARTHQUAKE is reported to have destroyed Amboyna, the chief city of the Molucca Islands, killing 50 persons and injuring about 200.

A WATER TANK COLLAPSED at Marshall, Minn., about Jan. 7, according to press reports. "The Manual of American Water-Works" for 1897 states that the tank was of wood and had a capacity of 60,000 gallons; also that it was supported by an iron tower 114 ft. high.

DERAILS ON HIGH-SPEED TRACKS in Illinois must in future be placed at least 400 ft. from the fouling point, wherever local conditions appear to render this neccessary. Formerly the distance required was 300 ft., but Mr. Wm. L. Tarbet, Consulting Engineer to the Railroad and Warehouse Commission of Illinois, states that this change in the rules has been made on account of the constantly increasing speed and weight of trains.

A SERIES OF CAR WHEEL TESTS is to be made by the New York Car Wheel Works and the P. H. Griffin Machine Works, of Buffalo, N. Y., on Jan. 21, and the members of the Central R. R. Club have been invited to attend the tests. Chilled wheels of special quality and design are to be subjected to the tests required in America and also in different European countries for the purpose of demonstrating the comparative value of steel tired and special quality chilled iron wheels for high grade service. A report of the tests will be given in our next issue.

THE RUSTING OF IRON AND STEEL is a subject of periodical discussion, and the experience with tanks of both materials furnished to breweries is an interesting case in point. The Goetz & Brada Mfg. Co., of Chicago, manufacturing copper and sheet iron work, informs us that from 8 to 20 years ago it furnished many tanks made of Bailey's iron, all of which are in good condition to this day, while tanks of steel (of the grade commonly known as tank steel) have given out, and sheets had to be replaced within three to six years.

THE SAND BLAST for cleaning locomotive tenders preparatory to repainting is gaining favor in railway paint shops. At the Dennison, O., shops of the Pittsburg, Cincinnati, Chicago & St. Louis Ry., the sand blast has been used for cleaning the rust and scale from locomotive tenders for about 18 months, and during this time the average cost of cleaning each tender ready for painting has been $2.50. Considering the thoroughness of the cleaning and the durability of the work which follows, Mr. A. R. Lynch, the foreman painter at these shops believes that there is no other method so economical. Similary favorable results are reported from the Erie R. R., which also uses the sand blast. Here crushed quartz sand or quartz and deposit sand mixed half-and-half are used with an air pressure of from 100 lbs. to 125 lbs., and a tank is thoroughly cleaned in about ten hours.

THE GLARE FROM ELECTRIC HEADLIGHTS has recently been investigated on the Peoria & Eastern division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., to determine whether its effect was to overpower the lights from colored signal lamps, as has been stated. The result of the tests, according to newspaper reports, was to show that there was no danger from this source. At a distance of 1½ miles the watchers on the engine equipped with electric headlights were able to distinguish clearly between red, green and white lanterns waived across the tracks. The clear white light from the locomotive seemed, if anything, to intensify and bring out the different colors more clearly.

TRACK ELEVATION IN CHICAGO is to be extended for 22 miles, according to new ordinances just prepared. This will involve the construction of several hundred subways and will cost about $2,000,000. The work is as follows: Chicago, Burlington & Quincy R. R., Blue Island Ave. to W. 48th st.; Chicago & Northwestern Ry., Blue Island Ave. to 12th St.; Chicago Terminal Transfer R. R., Blue Island Ave. to Kedzie Ave.; the tracks of the Pittsburg, Cincinnati, Chicago & St. Louis Ry., the Union Stock Yards & Transit Co. and the Chicago Terminal Transfer Co., from 12th St. to 39th St.; the tracks of the Chicago & Alton R. R., Madison & Northern R. R., and Atchison, Topeka & Santa Fe Ry., from 18th St. to Western Ave. The Chicago, Milwaukee & St. Paul Ry. has refused to accept the ordinance for the elevation of its tracks, on account of the provision for a subway for the Central Park boulevard, which, it claims, will seriously interfere with its yard grades.

A THIRD EAST RIVER BRIDGE between Brooklyn and Manhattan Island is advocated by Mr. John L. Shea, the new Commissioner of Bridges of Greater New York, and he has secured permission from the Board of Public Improvements to investigate and report upon the need and cost of such a structure. According to the newspaper interviews Commissioner Shea proposes the construction of an all railway bridge to be located either at the lower end of Manhattan Island or between the present Brooklyn Bridge and the New East River Bridge, now in process of construction about 1 mile further up stream. In reference to the proposed new bridge Mr. Shea is reported have said:

> Just what site would be determined upon has not been discussed, but it would be at a point where the principal railways of the city could readily connect and offer this greatly needed transportation improvement to the public. No estimates have been made in regard to the cost, but I understand that a bridge of this character could be built for something over $6,000,000. The railways would certainly be willing to pay a good.y sum for the privilege of crossing the structure, and it has been claimed that enough revenue could be derived to make the bridge ultimately pay for itself.

The present Brooklyn Bridge cost $20,000,000 and the New East River Bridge is estimated to cost $7,500,000. It is proposed that the city shall bear the expense of the new bridge and rent it to the railways.

IS HIGH BRIDGE A BRIDGE? is a question brought up by the creation of the new Department of Bridges for Greater New York. This department is to have charge of all bridges and is attempting to make a list of them. High Bridge, built for the conveyance of water and a part of the water supply system of the city, has always been in charge of the Croton Aqueduct Bureau, and Mr. George W. Birdsall, Chief Engineer of that bureau, claims that it now belongs to the Department of Water Supply. Mr. Birdsall claims that it is not a bridge at all, but is a component part of the Croton Aqueduct. People have been allowed to walk across it; but that is a matter of courtesy and accommodation. The viaduct at 155th St., and the proposed viaduct over the valley at Manhattanville, on the Riverside Drive, form a class by themselves; and it is now a question whether they are under control of the Department of Bridges or the Department of Highways.

A DECIDED INCREASE OF TYPHOID FEVER in certain parts of Philadelphia is said to have followed the accidental overflow of one of the city sewers into Wissahickon Creek, and thus into Schuylkill River above the waterworks intake from which the Queen Lane reservoir is supplied. The overflow was caused by the use of too great a quantity of water in flushing the sewer in question. The pumps at the station were stopped as soon as possible and the river flushed by water held in storage above before pumping was resumed. Another sudden rise in typhoid fever in this district occurred between Jan. 1 and 8, seven weeks after the overflow, and both rises were accompanied by an increased amount of the disease in other parts of the city than those supplied from this intake.

THE EFFECT OF SEWAGE ON OYSTERS is a subject suggested by Health Commissioner McShane, of Baltimore, Md., as a desirable one for investigation in view of the great amount of agitation now going on in that city over the relative merits of sewage disposal by dilution in the waters of Chesapeake Bay and by intermittent filtration. Dr. McShane says that for a very small sum oysters could be placed at points in the Potapsco River where they would be subjected to varying degrees of pollution, and their bacteriological condition could be studied before and after so placing them.

A NEW CONTINUOUS FLOW DEEP WELL PUMP.

By E. E. Johnson, M. Am. Soc. M. E.*

The difficulties encountered in obtaining town water supplies from surface sources has led to the development of the supplies held in the sandstone and gravel formations abounding in large areas throughout the United States. In some localities the wells flow, or can at least be pumped the same as surface supplies. In the large majority of cases, however, the water must be pumped from considerable depths, and much ingenuity has been brought to bear on the problem with no very satisfactory results. Practically only two methods of pumping deep wells are now used; namely, the direct-acting steam deep well pump, and the air lift pump. The air lift seems to offer some advantages in simplicity of mechanism, but, as was pointed out by the writer in Engineering News of April 22, 1897, its low efficiency, from 17% to 25%, prohibits its general use in places requiring large supplies from depths of 100 ft. and over. From 15,000,000 to 30,000,000 foot-pounds duty per 1,000 lbs. of dry steam is a fair average for single stage and two-stage compressors pumping against 100 ft. lift. Outside of the air lift the direct-acting steam deep well pump has had the field, securing a duty of from 2,000,000 to 5,000,000 foot-pounds.

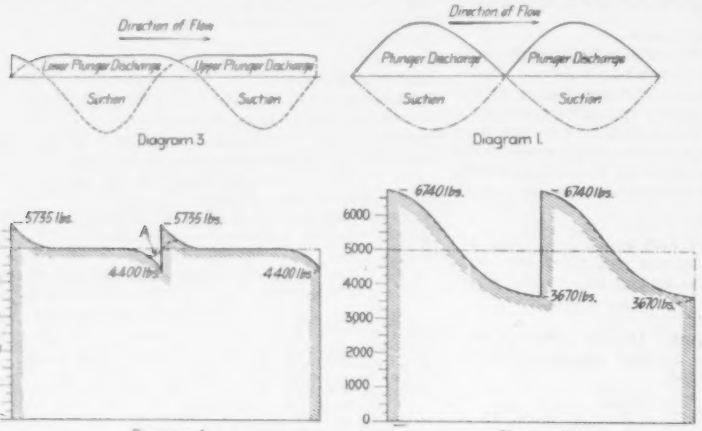


FIG. 1.—DIAGRAMS SHOWING COMPARATIVE PLUNGER SPEED AND PLUNGER LOAD IN A PUMP HAVING TWO SINGLE ACTING PLUNGERS AND IN A "CONTINUOUS FLOW" PUMP.

The older forms of direct-acting deep well pumps were single acting. They consisted of a pump cylinder and a steam cylinder mounted tandem. The pump cylinder was ordinarily a seamless-drawn brass tube, with a check valve at the bottom, and having a valved plunger. This cylinder was suspended from a drop pipe of slightly larger diameter than itself, or, if the well was cased with iron tubing, the cylinder might be locked into the casing, which then acted as a discharge pipe. The great distance between the steam and the pump cylinders in this construction necessitated that both should be single-acting in order that the strain on the long pump rod might always be a tensile strain. The discharge was manifestly on the up-stroke only.

These purely single-acting cylinders were followed by a cylinder having two plungers working one above the other. These two plungers were operated independently by means of cranks and connecting rods. One pump rod was a tube, and the other was a solid rod working inside the tube. Various forms of operating heads were used with these double-acting cylinders, but whatever the form, they alternately stopped and brought to a maximum the flow of the discharge column twice during each revolution. The effect of this is shown very clearly by the diagrams that follow.

Diagram I. shows by its vertical ordinates the plunger speed at every portion of the revolution for a double-acting pump, having two single-acting plungers, one above the other, in a single cylinder. Diagram II. shows graphically the variation in plunger loads caused by the changing rate of plunger velocity for a column pipe 7 ins. in diameter and 300 ft. long, containing about 5,000 lbs. of water with a 24-in. stroke pump running 30 revolutions per minute. It will be noted that the maximum plunger load is 6,740 lbs., an increase of 1,740 lbs. above normal at the instant of starting, and the minimum load is 3,670 lbs., or 1,330 lbs. below normal at the time of ending the stroke.

The operating mechanism, therefore, sustains a load changing from 3,670 lbs. to 6,740 lbs. in each revolution, involving an almost instant increase of 83½% of the minimum load. We say "almost instant." In theory the change is instantaneous, but it would be manifestly impossible to keep the air out of the water column, and make the machinery wholly inelastic; otherwise no machinery could resist the shock. Is it any wonder the problem of deep well pump design has been so baffling to designers?

The continuous flow pump described below was designed to meet the conditions of this exacting service and thus afford a satisfactory means of developing large subterranean supplies. The inelastic nature of the water column between the cylinder, which is often from 300 to 500 ft. from the surface, and the point where the pump mechanism is placed, has been the rock on which have been wrecked all attempts at design for this class of machinery. Obviously, to maintain the water column at a constant rate of motion is the remedy. The success with which this has been accomplished is illustrated in Diagram III., which is, for working conditions, exactly similar to Diagram I.; the height of any ordinate above datum showing as before the comparative velocity of the water column at that instant. It will be seen the variation is slight. The consequent variation in plunger load is shown in Diagram IV., the maximum load being 5,735 lbs., and the minimum, 4,400 lbs., a variation of 30½% of the minimum load. This type of pump has been operated continuously at speeds much in excess of that named, and still no shock or jar to its parts is perceptible.

The means of securing this result is disclosed in Diagram III. With the horizontal distance representing time, it will be noted that the up or working stroke of each plunger occupies about 60% of the time of a revolution, leaving 40% of the time for the down or idle stroke, and the strokes are so timed as to produce the continuous upward motion of the water column.

The mechanical details of the pump are shown plainly by the plan, Fig. 2, and by the front elevation, Fig. 3. As will be seen, only simple means are used to transmit the power. Two drive shafts with equal intermeshing gears give motion to two pump cranks whose centers are sufficiently offset to produce through the intermediate slides and blocks the alternate slow upward and fast downward motion required in the plungers.

To show the efficiency and economy of this new continuous flow deep well pump, it has been thought best to give the results of tests of actual plants. The plants selected are the three first erected, and they are located at Cambridge, Ill., Stockton, Ill., and Ames, Ia.

Cambridge, Ill.—The plant consists of a 36-HP. Otto gasoline engine, driving two pumps, a duplex double-acting power pump of 300 gallons per minute capacity, used for fire service or to pump to stand-pipe, and the continuous flow deep well pump, which latter is used to pump to the surface reservoir, lifting 252 ft., or to the stand-pipe direct, lifting 371 ft. Both pumps are connected to the engine by 10-in. double leather belts with 15-ft. belt centers. In the test for engine efficiency both belts were being driven, and their losses are included with the engine load, as it was a difficult task to remove the belts.

Data of Test.

Pump lift, in feet	252
Cylinder diameter, in inches	6¾
Pump stroke per revolution, in inches	41.25
Pump capacity per revolution, gallons	6.20
Duration of test, hours	1
Revolutions of pump per minute	11.6
Capacity of pump per minute, gallons	71.8
Water pumped per minute, reservoir meas., gals.	71.82
Slip of valves, per cent	3.10
Speed of gasoline engine per minute	290
Value of one explosion in horse-power, from card.	3
Explosions per minute, pump running	30
Explosions per minute, pump not running	18
Explosions per minute to run pump	10
Horse-power to pump	7
Horse-power from pump	4
Efficiency of pump, per cent	67
Total horse-power developed in engine	12.75
Horse-power to run engine and two belts	5.95
Efficiency of whole plant from power applied to water delivered, per cent	46

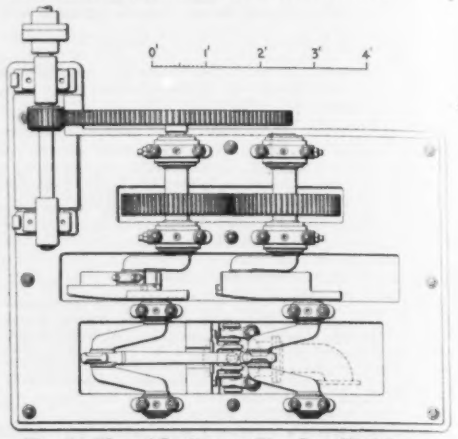


Fig. 2,—Plan of Continuous Flow Deep Well Pump. E. E. Johnson, M. Am. Soc. M. E., Designer. Henion & Hubbell, Chicago, Ill., Builders.

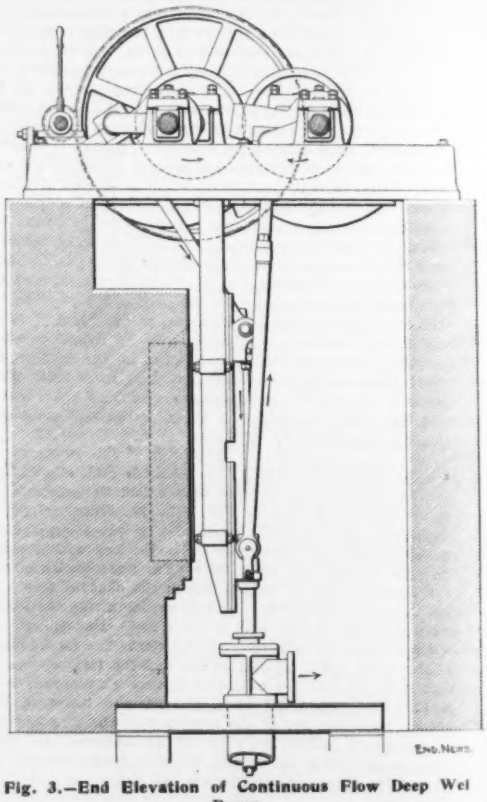
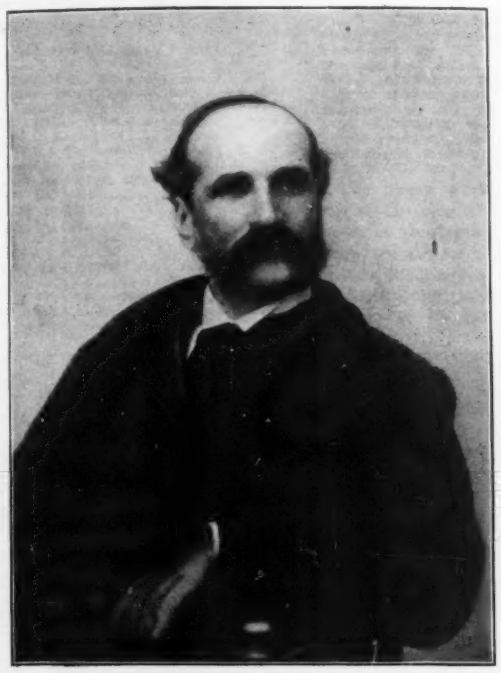


Fig. 3.—End Elevation of Continuous Flow Deep Well Pump.

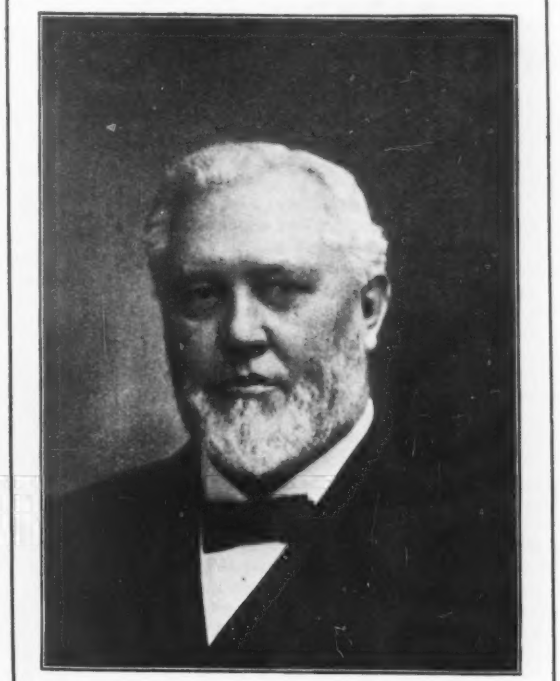
It will be noted in explanation that this plant was designed to handle 200 gallons per minute, but the well on test only gave 71.82 gallons. The whole plant is underloaded to give the best results, as it will be seen that of 12.75 HP. developed by a 36-HP. engine, 5.95 HP. or 46% of its load was used in driving itself and two belts, one of which was transmitting no power.

Stockton, Ill.—This plant consists of a 48-in. × 12 ft. horizontal tubular boiler, and a 10 × 12-in. automatic engine, which is connected direct to the pinion shaft of the continuous flow pump, Fig. 4, the intention being to add a lighting generator to the equipment later on. The water is pumped from a distance of 159 ft. below the surface to a reservoir excavated on a hill top 3,800 ft. away, and elevated 116 ft. above the pump. The discharge line is 8-in. cast-iron pipe. At the time

*"Mechanical Engineer," Henion & Hubbell, 61-69 North Jefferson st., Chicago, Ill.

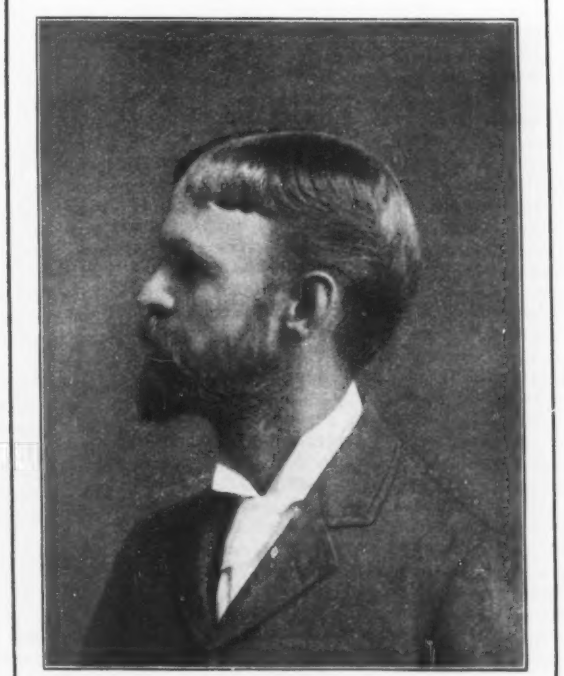


President of the American Society of Civil Engineers.



President of the American Society of Mechanical Engineers.

President of the American Institute of Mining Engineers.



President of the American Institute of Electrical Engineers.

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of the test no service connections had been made. Reservoir measurements were made by hook gage reading inches to the second decimal place. Two twelve-hour tests were made to determine the leakage from the reservoir and mains.

Data of Test.

Lift in feet	274½
Cylinder diameter, in inches	5¾
Pump stroke per revolution, in inches	41.25
Pump capacity per revolution, gallons, estimated.	4.64
Pump capacity per rev., gals., reservoir meas..	4.74
Duration of test, hours	4
Average revolutions of pump per minute	25.59
Capacity of pump per minute, gallons	118.66
Water pumped per minute, reservoir meas., gals.	120.97
Slip of valves, negative, per cent.	1 9-10
Average speed of driving engine	195.8
Size of engine, ins.	10 × 12
Steam pressure, lbs.	60
I. HP. average of 25 cards	13.21
HP. engine friction from two cards	1.69
HP. to pump	11.52
HP. from pump	8.32
Efficiency of pump, per cent.	72
Efficiency of pump and engine, per cent.	63

ing, and Prof. Bissell, of the Department of Mechanical Engineering, of the college.

Data of Test.

Pump lift, in feet	390
Cylinder diameter, in inches	5¾
Pump stroke per revolution, in inches	42
Pump capacity per revolution, in gallons	4.72
Pump cap. per rev., in gals., reser. meas.	4.90
Average revolutions of pump per minute	27.14
Water pumped per minute, reservoir meas.	133
Slip of valves, negative, per cent.	3 8-10
Duration of test, hours	1
Size of engine, ins.	8 × 16 × 8
Steam pressure, lbs.	90
Vacuum, in inches	18
Duty in ft. lbs. per 1,000 lbs. dry steam	45,500,000

The pump works smoothly and without shock under the conditions named. A notable development in the tests at Stockton and at Ames is the negative slip of the valves; that is, the pump actually discharged more water than its displacement, a condition due, doubtless, to the fact that the water column, being always in motion upward, tends to retain its velocity constant when the plunger slows up and so opens the valve in the plunger, the water crowding through in this manner being sufficient to counterbalance the slip of the water past the packing in addition to accounting for the excess volume amounting to about 4% of the plunger displacement, delivered to the reservoir.

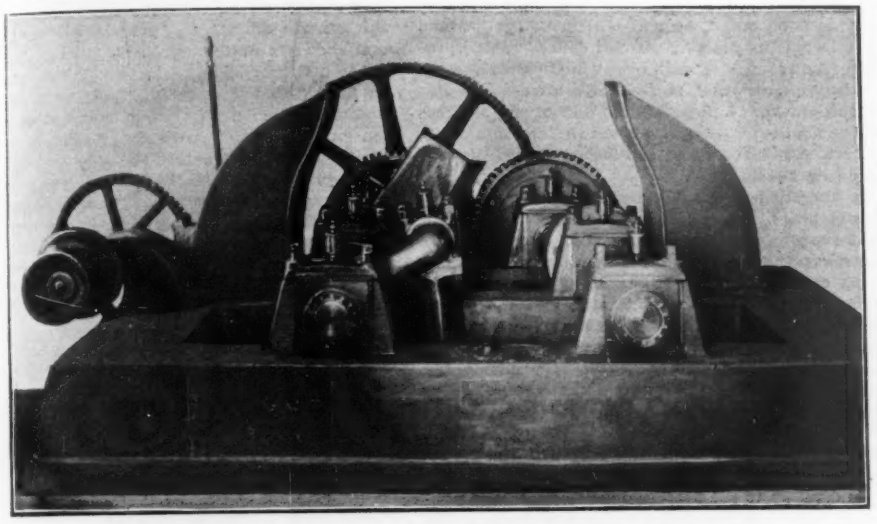


FIG. 4.—CONTINUOUS FLOW DEEP WELL PUMPING PLANT AT STOCKTON, ILL.
Side View, showing shaft and quick return arrangement.

The well was an old one and, for local reasons, was not examined at the time the machinery was placed. Later developments show the well bore to be crooked and make it probable that this lowered the efficiency of the pump somewhat.

Ames, Ia.—This plant belongs to the Iowa State College of Agriculture and Mechanic Arts. The

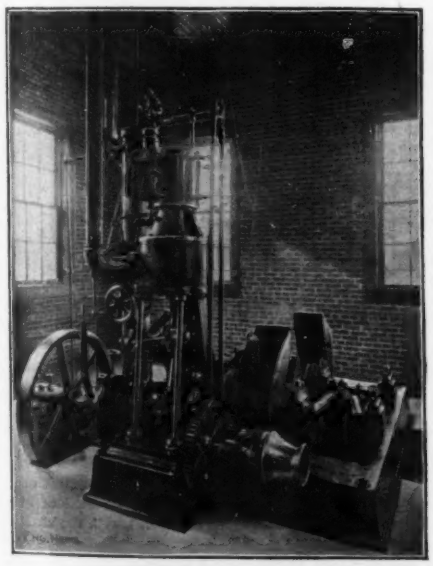


Fig. 5.—Continuous Flow Deep Well Pumping Plant at Ames, Iowa.

cylinder is 300 ft. from the surface and pumps direct to the elevated tank, 156 ft. above. The pump is furnished with tandem compound engine direct connected, as shown in Fig. 5. Full data of tests on this plant are not available, but will shortly be made the subject of a special bulletin by Prof. Marston, of the Department of Civil Engineering.

The above plants are none of them large, but the conditions are such as have baffled all other types of machinery. The handling of large volumes of water under similar conditions is a matter of correct design only. Plants of one-half and three-quarter million gallons daily capacity are soon to be installed. Enough has been done to make it certain that satisfactory deep well supplies can now be secured, and the equipment furnished on a duty basis corresponding to the practice for surface pumping.

We have built and will shortly instal two pumps of this type of 500,000 gallons daily capacity each for the Waukesha Water Co., at Waukesha, Wis. The air lift has been in operation at this plant, the air being furnished by a single stage two cylinder compressor driven by a twin Corliss engine with air and steam cylinders placed tandem. The average results being as follows:

Lift in feet	100
Water pumped per minute, gallons	820
I. HP. of engine	112
HP. from pump	20½
Efficiency of plant	18.3%

The Continuous Flow pumps will be driven by one of the two engine cylinders (the idle one being kept as a reserve), pumping against a lift of about 260 to 280 ft. The volume to be secured from the two wells is as yet not fully determined. The change in type of pumping machinery was determined on solely because of the economy to be obtained. The results secured from the continuous flow pumping plant will be made the subject of a later communication.

We have also the contract for two of these pumps to be put in at the village of Riverside, Ill., near Chicago, each plant to be 750,000 gallons daily capacity, and to be driven by its own engine directly connected, the machine being similar in type to that of the pump at Ames, Ia. We have secured our patent, which is number 595,175, dated Dec. 7, 1897. Foreign patents are also pending.

THE PRESIDENTS OF FOUR AMERICAN ENGINEERING SOCIETIES.

(With portraits.)

We present to our readers herewith, in accordance with our annual custom, the portraits of the presidents of the four principal American engineering societies of national scope, with notes as to the life and professional career of each.

Mr. Alphonse Fteley, who has just been elected President of the American Society of Civil Engineers, was born in Paris, France, in April, 1837. He commenced his professional career by serving in several engineering offices in Europe, and at first applied himself especially to mill engineering. In 1865 he came to the United States, and for a year was a mechanical draftsman in connection with the construction of engines for river steamboats. In 1866 he became an assistant to the late William E. Worthen, Past President of the American Society of Civil Engineers, and was employed by him on a variety of civil, hydraulic and mechanical engineering work until 1870. In the latter year Mr. Fteley opened an office for general engineering practice, and was engaged in highway construction, surveying, bridge work and especially in hydraulic engineering. At times he was professionally associated with Wm. E. Worthen, J. P. Kirkwood and other prominent engineers.

In 1873 Mr. Fteley was called to Boston, and was placed in charge of all the work of investigation and construction for the Sudbury River Water-Works system, as Resident Engineer, under Mr. Joseph P. Davis, M. Am. Soc. C. E., then City Engineer of Boston. During his long service in this important position Mr. Fteley made extended and valuable gagings to determine the flowing capacity of brick structures, some results of which were published in the Transactions of the American Society of Civil Engineers. In 1880 he was made Chief Assistant City Engineer of Boston, and remained in that office for four years.

In 1884 Mr. Fteley was appointed Principal Assistant Engineer of the Aqueduct Commission of New York, and had a prominent part in the general design and detail of this great water supply system. He was later, in 1886, made Consulting Engineer to the Commission, and in 1888 he became the Chief Engineer and still holds that office.

Aside from his more permanent engagements Mr. Fteley's services have been in frequent demand as a consulting engineer, for the design of and reports upon many important engineering projects and he has also practiced as an engineering expert in cases before the courts. Among these engagements may be mentioned his service as constructing engineer for the completion of the Southern Boulevard in New York, from Third Avenue to Jerome Park, and for several minor water supply systems. As Consulting Engineer he reported upon the lining of the Hoosac Tunnel; on additional water supplies for St. Johns, N. B., Albany, N. Y., Cincinnati, O., Brooklyn, N. Y., Rochester, N. Y., Newton, Mass., Cambridge, Mass., among other places, and also upon dams and reservoirs for various cities. He examined and reported upon systems of sewerage for Brooklyn, N. Y., Hoboken and Newark, N. J., and upon the purification of the valley of the Passaic River. He reported upon the accident to the Brooklyn Aqueduct, in 1891, and upon the advisability and cost of repairing the aqueduct tunnel in Washington, D. C. Mr. Fteley was consulting engineer to the first rapid transit commission of Boston, and he reported to the rapid transit commission of New York and to the Long Island Railway Company, on the proposed tunnel under the East River. He was also employed as consulting engineer during the construction of the additional water supplies of Newark, N. J., and Rochester, N. Y., and filled a similar position in the service of the Metropolitan Water Board of Massachusetts.

Mr. Fteley was elected a member of the American Society of Civil Engineers on Jan. 5, 1876, has served as an officer of the society and has

contributed a number of professional papers to its "Transactions."

Mr. Charles Wallace Hunt, who was elected President of the American Society of Mechanical Engineers in December last, is well known to our readers as the president and principal owner of the C. W. Hunt Co., manufacturers of machinery for handling coal and other materials, narrow gage railways, etc.

Mr. Hunt was born Oct. 13, 1841, at Candor, Tioga County, in Central New York. He received his education at the Cortland Academy, Homer, N. Y., taking the scientific course, expecting to become a civil engineer and go into railroad work. His plans were changed, however, by the war of the Rebellion and he became a government special agent, acting under orders from Mr. Stanton, Secretary of War, his services being chiefly in connection with taking care of the freedmen as they escaped from the Confederate and came into the Union lines. For several years after the war Mr. Hunt was out of health. When he was able to resume active work he embarked in the coal business, and was in this way led to study the problem of economical methods of handling and storing coal. In 1872 he started the business of building coal handling machinery, and established works at West New Brighton, Staten Island. The engenious and novel devices invented and patented by Mr. Hunt have in many respects revolutionized the handling of coal. The Hunt automatic railway, for example, is used in coal storage yards all over the world.

Besides coal handling appliances, Mr. Hunt has been a prolific and original inventor in numerous other fields of mechanical engineering, and has taken out over 100 patents. His works above referred to have had a continuous growth since their establishment and now conduct a great volume of business, while a branch has recently been established in Germany. Besides the work in connection with his regular line of business, Mr. Hunt has done considerable civil engineering work in wharf construction, the building of docks, wharves, storage warehouses, etc. He has also given attention to the architectural design of power stations, coal handling structures, etc., and is the president of several manufacturing companies, besides the one that bears his name.

Mr. Hunt became a member of the American Society of Mechanical Engineers in 1885. He served as a Vice-President from 1892 to 1894, and was for several years the chairman of publication committee. He is a member also of the American Institute of Mining Engineers, the New York Electrical Society, the Engineers Club of New York, and the Natural Science Association of Staten Island. Among commercial organizations he is a member of the Chamber of Commerce of New York, Vice-President of the Richmond Co. Savings Bank, and is now President of the Staten Island Chamber of Commerce.

Dr. Thomas Messinger Drown, President of the American Institute of Mining Engineers, was born March 19, 1842. He was educated at the Philadelphia Central High School, where he graduated in 1859. He then took up the study of medicine and three years later received the dgree of M. D. from the University of Pennsylvania. After a brief period of practice as a physician, he turned to chemistry as his life work, and studied under Professors Brush and Johnson at Yale, and under Professor Gibbs at Harvard. Three years were spent in Germany in the study of chemistry and matallurgy, partly at the School of Mines at Freiberg and partly under Professor Bunsen at Heidelberg. He subsequently established himself as an analytical chemist at Philadelphia, and removed in 1874 to Easton, Pa., to become Professor of Chemistry at Lafayette College, where he remained for seven years. In 1873 he was elected Secretary of the American Institute of Mining Engineers, and retained that position by unanimous re-election until he resigned it in 1883, to the universal regret of his associates. In 1885 he accepted the Professorship of Chemistry at the Massachusetts Institute of Technology. At the time of his resignation, 1895, the department had 21 instructors and 500 students. From 1887 to 1895 he was in charge of the chemical department of the Massachusetts State Board of Health in its investigation of the natural waters of Massachusetts, on which some $250,000 has been expended by the state. The importance of its results has been universally recognized. The map of "Natural Chlorine in the Waters of Massachusetts," prepared by him, with the co-operation of the engineers of the Board, as the graphic epitome of thousands of analyses, is a brilliant illustration of the value of induction from accurate and adequate data. The results of his very extended investigations of the sanitary condition of water were published for the most part in the annual reports of the Massachusetts State Board of Health. His papers on Metallurgy and Chemistry may be found in the Transactions of the American Institute of Mining Engineers.

Dr. Drown's work as Secretary of the Institute and editor of the first eleven volumes of its Transactions, deserved, and received, the highest praise. He has done much, by personal investigation and by stimulating his professional colleagues, to promote the adoption of rapid, convenient and accurate methods of analysis, suited for commercial work. In recognition of these labors, and of his services to the Institute, he was elected in 1884 one of its honorary members; and in February, 1897, he was made its President.

In the spring of 1895, Dr. Drown was elected President of Lehigh University, and in June of that year he was inaugurated. He has for years given careful thought to the training of engineers, being convinced that the standing of engineering as a profession depends in large measure upon the character of the training given in engineering schools. As President of a successful technical school, he has found opportunity for developing and applying those principles of education of whose soundness he had become convinced as the result of wide experience and observation. While fostering and encouraging in every way the greatest thoroughness in those studies which lead up more directly to the professional work, in the narrower sense, of the engineer, he has made it his aim to extend and, above all, to strengthen those elements in the course of study which make for a broader culture; being led to this by the conviction that the engineering profession needs not merely men who are thoroughly equipped with technical theories and applications, but men who are prepared to take their places as active and useful members of the social and political world.

The degree of Doctor of Laws was conferred upon Dr. Drown by Columbia University in June, 1895.

Dr. Francis B. Crocker, who was elected President of the American Institute of Electrical Engineers at that society's last annual meeting, was born in New York city July 4, 1861. At an early age he developed a taste for experimental work and engineering studies, and when only 17 years old entered Columbia College, New York city, registering in the School of Mines. After four years spent in the study of physics, chemistry, mining and other engineering subjects, he was graduated in 1882 as a mining engineer. One year later he entered into partnership with Mr. Chas. G. Curtis, forming the firm of Curtis & Crocker, patent attorneys and patent experts. During this period spare hours were spent in experimental study in conjunction with Messrs. Schuyler S. Wheeler and C. S. Bradley, and his partner, C. G. Curtis. Their investigations included telegraphy, telephony, electro-chemistry, electric lighting and the use of electricity for power purposes, and resulted in the development of a number of inventions.

In 1886 the C. & C. Electric Motor Co. was established by Messrs. Curtis and Crocker. This company was one of the pioneer electrical manufacturing enterprises, and the success of its motors did much to establish a general confidence in electrical apparatus. Two years later, in 1888, in company with his former collaborator, Mr. S. S. Wheeler, he formed the Crocker-Wheeler Electric Co. This company has also been very successful and its apparatus is widely known and extensively used. The year following Mr. Crocker was offered and accepted a professorship and the charge of the department of electrical engineering, then just established at Columbia University.

At the Columbian Exposition in 1893 he was made permanent secretary of the International Electrical Congress. It was just before this that he proposed the name "henry" which was adopted by the Congress for the unit of inductance. As secretary he rendered valuable assistance to Dr. Elisha Gray, President of the Congress, and after its adjournment the publication of its proceedings was given into his charge.

Besides being a life member of the American Institute of Electrical Engineers, Prof. Crocker has in the past been one of its vice-presidents for two terms, as well as a manager for a like period. While representing the Institute in the National Conference on Standard Electrical Rules, he took active part in all its work, and considerable credit is due him, as chairman of the Committee on Code, working in conjunction with the National Board of Fire Underwriters for the excellent rules the general adoption of which by underwriters and societies indicates clearly their completeness.

As an author he is, perhaps, best known through his book "Electric Lighting," although "The Practical Management of Dynamos and Motors," written in conjunction with Dr. S. S. Wheeler, and many papers read before societies or published in the engineering journals have received recognition.

Although a comparatively young man, Prof. Crocker has, through his ability and untiring effort, won for himself a name as a manufacturer, as a teacher, as an author and as an engineer.

TESTS OF THE STRENGTH OF BRACKETS ON CAST-IRON COLUMNS.

In our last issue we gave an account of a series of tests of cast-iron columns, made by the Department of Buildings of New York city, at Phoenixville, Pa., in December last. After the columns were broken, as described in our article, the strength of the brackets, which were cast on the columns, was tested. The bracket end of each broken column was squared up in a lathe, so as to obtain a proper bearing in the platen of the testing machine, and the load was then applied, as shown by Fig. 1.

We have summarized from the report of Mr. W. W. Ewing, the engineer of the Department, who was in charge of the tests, the results of the bracket tests, and they are given in Table I. The notes following, concerning the character of the fractures, etc., are also extracted from his report:

Notes Concerning the Fractures.

No. 1.—The fracture tore out the main body of the column for a depth of about 6 ins., and width of about 8 ins. The angle of fractured surface with the surface of shelf at center of shelf was about 15°; angle at inner lines of brackets about 45°; angle at edges of shelf about 90°. Metal rather coarse, especially where it cooled slowest.

No. 2.—Metal broke off squarely at edges of bracket at an angle of about 30°, with the surface of the shelf at the center of the shelf; between the center and the two edges

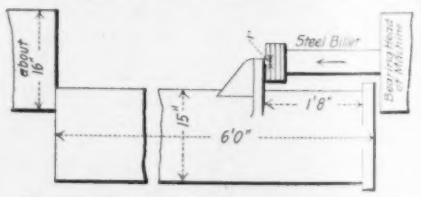


Fig. 1.—Manner of Applying Loads to Brackets.

the angle of fracture varied between 30° and 90° at intermediate points. Bracket tore out from the column in the same way as No. 1. Quality of metal same as No. 1.

No. 3.—Bracket tore out part of the shelf, leaving, approximately, a round hole. Fracture surface at center of shelf made an angle of about 10° with surface of shelf, this increasing each way to about 45° with the shelf at the edges of shelf.

No. 4.—Tore through only a small hole in the column. Angle of fracture at the middle of shelf about 45° to the shelf surface and increased gradually to 90° at edges of shelf. Metal uniform, flawless, coarse medium.

No. 5.—Angle of fracture at middle of shelf 20° with shelf surface; angle at sides 90°, and on line of outside of brackets 45°. Metal medium grain, uniform, flawless.

No. 6.—Angles of fracture with plane of top of shelf, at middle of bracket, 20°; at edges, 90°. Metal medium grain, flawless.

No. 7.—Metal medium grain, flawless.

TABLE I.—RESULTS OF TESTS OF BRACKETS ON CAST-IRON COLUMNS.

No. of test.	Dimensions, as in Figure.	Column number and diameter.	Bracket for girder or beam.	Load distributed, as in Fig. 5; or at end, as in Fig. 3.	Breaking load, lbs.	Area of fractur'd surf. abv.bot'm of shelf* sq.ins.	Thickness of metal in column, top of shelf.
1.	No. 2.	II., 15 ins.	Girder.	Unequally distribtd.‡	363,000	20.15	1 1-16 ins.
2.	" 3.	" "	"	End.	153,500	20.88	.....
3.	" 4.	" "	Beam (small).	Distributed.	133,700	10.	.....
4.	" 6.	" "	" "	End.	69,800	8.25	1 1-16 ins.
5.	" 2.	I., 15 ins.	Girder.	Distributed.	267,300	21.	.....
6.	" 2.	" "	"	End.	146,800	21.	.....
7.	" 4.	" "	Beam (small).	Distributed.	131,000	8.61	.....
8.	" 4.	" "	" "	End.	49,140	8.3	.....
9.	" 7.	B 2, 15 ins.	Girder.	Distributed.	233,000	27.19	.....
10.	" 7.	" "	"	End.	133,700	23.07	.....
11.	" 7.	" "	Beam (small).	Distributed.	114,600	Not meas.†	.....
12.	" 7.	" "	" "	End.	49,100§	Not meas.	.....
13.	" 7.	B 4, 15 ins.	Girder.	Distributed.	252,500	18.	1⅛ ins.
14.	" 8.	" "	"	End.	141,800	21.14	1⅛ ins.
15.	" 9.	XVI., 8 ins.	.....	Distributed.	335,700	Not meas.	1 3-16 ins.
16.	" 9.	XVII., 8 ins.	.....	End.	131,000	Not meas.	1 1-16 ins.
17.	" 10.	No. 7, 6 ins.	.....	Distributed.	142,000	20.3*	.....
18.	" 10.	No. 7, 6 ins.	.....	End.	69,800	Not meas.	.....
19.	" 10.	No. 8, 6 ins.	.....	Distributed.	122,800	20.9*	.....
20.	" 10.	No. 8, 6 ins.	.....	End.	72,900	Not meas.	.....
21.	" 2.	No.6, 15 ins.	Girder.	Distributed.	159,300	27.9	.....
22.	" 2.	No.6, 15 ins.	"	End.	95,500	26.2	.....

* The area of fracture measured was the entire developed area of fracture which lay above the plane of the bottom of the shelf, this portion of the fracture being supposed to have taken place by tension or shearing. The fractured area below this plane was not measured. In tests Nos. 17 and 19 the fracture took place by shearing parallel to the axis of the column, and the area measured is the whole area sheared.

‡ Greater near the shaft.

† No. 11.—This bracket broke in a peculiar manner, taking out a piece of the column shaft above the bracket, 4½ ins. wide (average) by 11 ins. high.

§ No. 12.—The figure 49,100 does not indicate the strength of the bracket, as the column had been weakened by the tearing out of the other three brackets.

TABLE II.—STRENGTH OF CAST-IRON BRACKETS, COMPUTED FROM TESTS.

No. of test.	Breaking load, lbs.	Area of fracture abv.b't'm shelf A, sq. ins.	Area of vertical section of Brackets: Shelf, B, sq.ins.	Below shelf, sq.ins.	Total, C, sq.ins.	Load, per sq. in. of area, approximate.—A, lbs.	B, lbs.	C, lbs.	Load on end = E, or distributed = D.
1.	363,000	20.15	22.5	16.5	39	18,000	16,100	9,300	D.
2.	153,500	20.88	22.5	16.5	39	7,300	7,000	3,900	E.
3.	133,700	10.	7.5	6.2	13.7	13,400	17,700	9,800	D.
4.	69,800	8.25	7.5	5.6	13.1	8,400	9,200	5,300	E.
5.	267,300	21.	22.5	16.5	39	12,700	11,900	6,900	D.
6.	146,800	21.	22.5	16.5	39	7,000	6,500	3,700	E.
7.	131,000	8.61	7.5	6.2	13.7	15,200	17,500	9,600	D.
8.	49,140	8.3	7.5	6.2	13.7	5,900	6,600	3,600	E.
9.	233,000	27.19	21	15	36	8,200	11,100	6,500	D.
10.	133,700	23.07	21	15	36	5,800	6,400	3,700	E.
11.	114,600		Not given.						
12.	49,100		Not given.						
13.	252,500	18.	21	15.7	36.7	14,000	12,200	6,900	D.
14.	141,800	21.14	20.7	13.8	34.5	6,700	6,900	4,100	E.
15.	335,700	.....	16.6	33.8	50.4	.....	20,200	6,700	D.
16.	131,000		Not given.						
17.	142,000[1]	20.3[2]	6	7	13	7,000[3]	23,700	10,900	D.
18.	69,800[1]	.....	6	7	13	.....	11,600	5,400	E.
19.	122,800[1]	20.9[2]	6	7	13	5,900[3]	20,500	9,400	D.
20.	72,900[1]	.....	6	7	13	.....	12,100	5,600	E.
21.	159,300	27.9	22.5	16.5	39	5,700	7,100	4,100	D.
22.	95,500	26.2	22.5	16.5	39	3,600	4,200	2,450	E.

[1] Nos. 17, 18, 19 and 20, that is, all the brackets in 6-in. columns, broke by shearing through the metal of the bracket.

[2] Sheared areas.

[3] Breaking load per sq. in. of sheared area.

No. 8.—Angle of fracture with top surface of shelf, at center of shelf, 15°; at edges of shelf, 45°.

No. 9.—Angles of fracture with surface of shelf 10° to 15° for 3 inches on either side of center of bracket, 90° at edges of shelf, and 45° at edges of brackets. Metal fine grain at edges, medium towards center, free from flaws.

No. 10.—Angles of fractured surface measured from plane at top of shelf, at center of shelf, 30°; at edges of shelf, 90°; on outer line of brackets, 45°. Metal medium grain, rather fine at edges; one flaw, about ⅜ × ¾-in. at top of fractured surface.

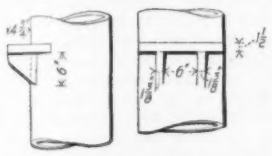


Fig. 2.—Tests Nos. 1, 6, 21, 22.

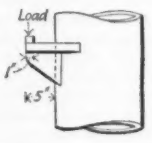


Fig. 3.—Test No. 2 Showing Manner of Application of Load.

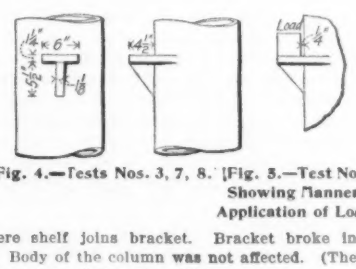


Fig. 4.—Tests Nos. 3, 7, 8.

Fig. 5.—Test No. 3 Showing Manner of Application of Load.

No. 11.—This bracket broke in a peculiar manner, taking out a piece of the column shaft above the bracket 4½ ins. wide (average) by 11 ins. high. (See column at left of photograph, Fig. 11.) Metal medium grain, no flaws.

No. 12.—The breaking load, 49,100 lbs., does not indicate the strength of the bracket, as the column had been weakened by the tearing out of three other brackets, and the body of the column failed in this case.

No. 13.—Angle of fracture with surface of shelf 10° for 11 ins. of the width of the shelf and 90° at edges. Metal medium to coarse grain, no flaws.

No. 14.—Angles of fractured surface of shelf with top surface of shelf 12° at center, 90° at edges. Metal rather coarse at center and finer at edges.

No. 15.—Bracket broke as shown in Fig. 12. Metal free from flaw and medium coarse.

No. 16.—Fracture very irregular, as in Fig. 12. Metal medium grain, uniform and flawless.

No. 17.—Metal flawless and medium grain. The bracket failed by shearing off direct, the fractured surface of the rib being pear-shaped, as shown in Fig. 13.

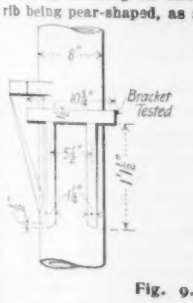
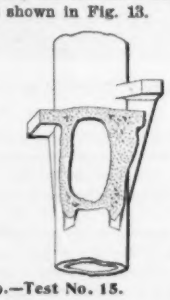


Fig. 9.—Test No. 15.



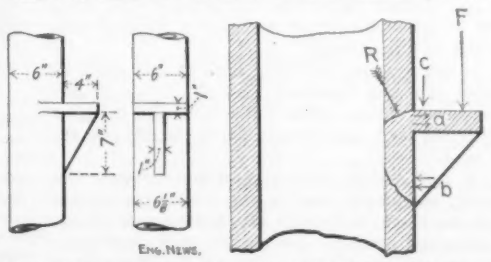


Fig. 10.—Tests Nos. 17, 18, 19, 20.

Fig. 15.—Sketch Showing Probable Manner of Fracture.

No. 18.—The bracket sheared off at its junction with the column. The fractured surface revealed a shrinkage cavity about ¾-in. in diameter, besides more or less defective metal. Part of the surface was dark and more or less honeycombed; the other part was fine and even.

No. 19.—The bracket failed by shearing. The lower part of the bracket carried away part of the shaft, leaving a pear-shaped surface similar to No. 17. Two small shrinkage cavities were revealed near the bottom of the bracket, one about 1 in. in diameter and the other about ¼-in. diameter. Metal fine and uniform, except the flaws noted.

No. 20.—The bracket sheared off at its junction with the shaft. The metal was medium and uniform, except that there was a shrinkage crack, a cavity about ¾-in. in diameter, and defective metal over an area of 1¼ by 1½ ins.

No. 21.—The metal was sound, very fine grained, light gray in color and very brittle. Angles of fracture with surface of shelf 45° at middle of shelf, increasing on either side to 90°. Metal was torn through shaft on one side. (See Fig. 14.)

No. 22.—Metal same quality as No. 21, one flaw 2 sq. in. where shelf joins bracket. Bracket broke in three pieces. Body of the column was not affected. (The pieces are shown at the left in Fig. 14.)

From the notes above, and the photographs reproduced herewith, it will be seen that the fractures take a variety of shapes according to circumstances. In the tests of the brackets on the 15-in. columns, a hole was torn into the body of the column in every case except in test No. 22. In the two tests of brackets on 8-in. columns, tests Nos. 15 and 16, holes were torn in the body of the column, but in the four tests of brackets on 6-in. columns, the brackets were broken off from the column. The report says that the brackets were sheared off, but it is quite possible that the fracture may have occurred by transverse stress, instead of by shearing. In the two tests, Nos. 17 and 19, with the load distributed over the shelf of the bracket, the fracture extended into the column at the bottom of the rib, making what is called a "pear-shaped" fracture, the area of the fractured section being much larger than the minimum section under shear at the junction of the bracket with the column. In the two tests on the same column, Nos. 18 and 20, made with load applied at the end of the bracket, the fracture, whether due to shearing or to transverse stress, took place at the junction of the bracket with the column, the area of the fractured section being, therefore, much smaller than that in the other two tests.

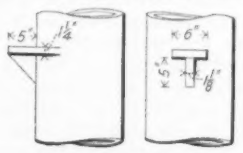


Fig. 6.—Test No. 4.

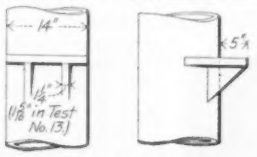


Fig. 7.—Tests Nos. 9, 10, 13.

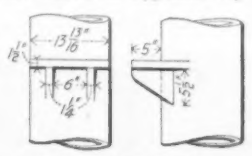


Fig. 8.—Test No. 14.

In the tests in which there was a hole torn in the column, it would appear that the fracture occurred in a manner which cannot be analyzed as either simple transverse or shearing stress. The accompanying sketch, Fig. 15, may give an idea of what probably occurred. The load on the bracket, represented by F, causes a tensile stress (a) in the shelf of the bracket, and an equal compressive stress (b) in the lower part of the ribs. Besides this, it causes a shearing stress (c) acting to shear the bracket from the column. The shearing stress (c) and the tensile stress (a) acting together to make a resultant stress R, which is opposed by the resistance to being pulled apart of the metal in the body of the column through a section at right angles to the direction of this resultant. Through this section, if its area is sufficiently small, or if it is weakened, as is quite likely, by shrinkage strains due to the right-angled corner of the junction of the shelf with the column, the initial fracture will take place. As soon as the first crack at this point is started the metal down the sides of the brackets is torn by shearing in detail, tearing just as a sheet of paper may be torn by the fingers.

The calculation of the probable breaking strength of a bracket on a cast-iron column upon any theoretical or scientific basis is practically impossible, for many of the necessary factors for such a calculation are either uncertain or lacking entirely. Among these factors are: the tensile, compressive, transverse and shearing resistances of the cast iron, modified as they are by the greater or less fineness of the grain, which is caused not only by the nature or composition of the iron itself but by the rate of cooling of the casting; also the thickness of the metal in the column and in the several parts of the bracket, which may determine in what manner the fracture may take place. The calculation of the strength of a cast-iron bracket thus defying analysis on a theoretical basis it remains to discover,

if possible, some "rule of thumb," based on experiment, by which its probable strength may be approximated. The data given in the report of the tests under consideration include, with the breaking loads, measurements of the actual fractured surface taken above the plane of the bottom of the shelf, in those cases in which the fracture made a hole in the column, and of the whole

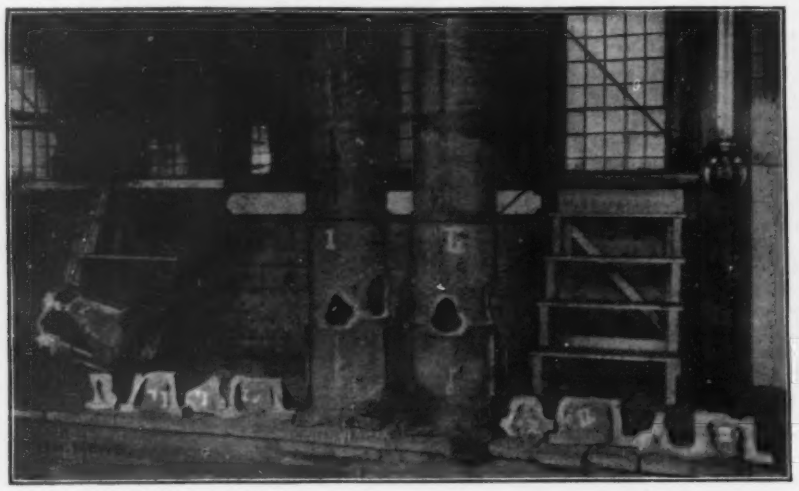


FIG 11.—FRACTURE OF BRACKETS ON 15-IN. COLUMNS, B2, I. AND II.

fractured surface in those cases (tests Nos. 17 and 19) in which the shelf broke off at its junction with the column and the rib tore out a portion of the metal of the column, making what is called the pear-shaped fracture. Besides these measurements we have, from the dimensions of the brackets, the sectional areas of the shelf, and the areas of the ribs at their junction with the column, and the sum of these two areas. Assuming that in those cases in which a hole was torn in a column the strength of the bracket bears some relation to the three areas, viz.: the actual area of fracture measured above the plane of the bottom of the shelf, the sectional area of the shelf, and the total sectional area of shelf and ribs taken together, we may by dividing these three several areas into the breaking load obtain three values of strength per square inch for the different brackets tested. The results of computations in this manner, in round numbers, are given in Table II., and are plotted in the accompanying diagram, Fig. 16, in which A is the breaking load per square inch of actual

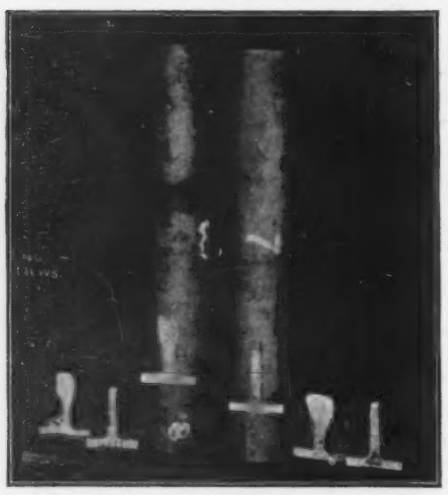


Fig. 13.—Fracture of Brackets on 6-in. Columns, Nos. 7 and 8.

fractured area measured above the plane of the bottom of the shelf; B is the breaking load per square inch of vertical section through the shelf, and C is the breaking load per square inch of the total vertical section.

It will be seen from the diagram that the strength per square inch of fractured area, measured above the plane of the bottom of the shelf, and the strength per square inch of sectional area of the shelf bear generally some relation to each other, but the range of variation from an average value is very great. The strength per square inch of total vertical section of the bracket is in every case much lower than the other strengths, as would be expected from the fact that the divisor, the area of section, is greater than the other areas, but it also shows some signs of an approach to uniformity in different tests.

The average strength per square inch of total vertical section for the tests with distributed loads is about 8,000 lbs., and for the tests with end loads 4,200 lbs. Leaving out the tests Nos. 21 and 22, which seem to be exceptional on account of brittleness of the iron in the brackets, the range with distributed loads is from 6,500 to 10,900 lbs. per sq. in, and for end loads from 3,600 to 5,600 lbs. per sq. in.

All of the figures are surprisingly low. We know of no other records of tests of brackets in cast-iron columns with which they may be compared, but we think it very unlikely that any engineer designing brackets for such columns to carry any given load would have used such low figures for the probable breaking load as these tests have given.

The most important conclusions to be drawn from the tests here described seem to be the following:

1. That a bracket on a cast-iron column of the ordinary construction will usually not break through the metal of the bracket itself either by transverse strain or by vertical shearing, but it will be torn away from the column, leaving a hole, the upper portion of the fracture beginning at the upper corner of the shelf, and extending through the column at an angle slightly inclined to the horizontal; the lower portion of the fracture extending downwards and outwards through the column at an angle of about 45°.

2. If the total area of fractured surface measured above the plane of the bottom of the shelf be divided into the breaking load, the breaking strength per square inch of fractured area thus computed ranges from 5,700 to 18,000 lbs., when the load is distributed over the bracket, and from 3,600 to 8,400 lbs. when the load is applied near the end of the bracket.

3. If the vertical sectional area of the shelf be divided into the breaking load the strength per square inch ranges from 7,100 to 23,700 lbs. for distributed load and from 4,200 to 12,100 lbs. for end load.

4. If the entire vertical section through the bracket, including that of the vertical supports below the shelf, be divided into the breaking load, the shearing strength per square inch thus computed ranges from 4,100 to 10,900 lbs., averaging 8,000 lbs. for distributed load, and from 2,450 to 5,600 lbs., averaging 4,200 lbs. for end loads.

5. That brackets projecting from 4 to 5 ins. from columns will bear only half as great a load when the load is applied at the end of the bracket, as it will when the load is distributed over the shelf of the bracket.

6. That the shelf of a bracket should be so made that the load cannot be concentrated near the end of the bracket, but must be carried as close to the column as possible.

THE SIGNAL DEPARTMENT ON AMERICAN RAILWAYS

By W. H. Elliott.**

Now that railway signaling in this country is fast approaching the dignity of a separate department in the operation of a railway, it behooves us as the heads of such a department to endeavor to define its duties to the end that a proper recognition may be had of the responsibility of the position, and the forces so organized that the best results will be obtained.

At the present time, it is hard to find any two roads on which the duties and power of the man in charge of the

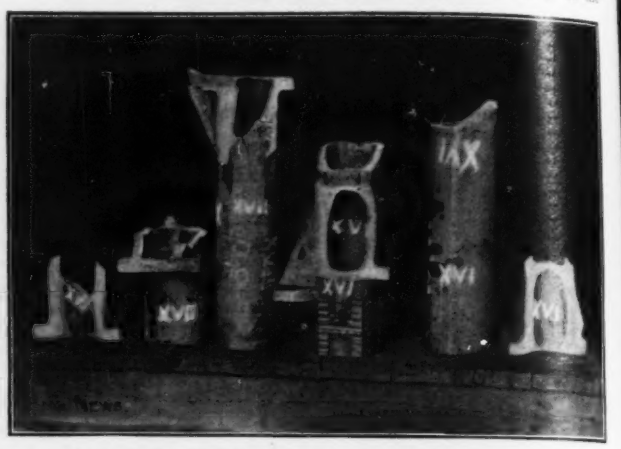


FIG. 12.—FRACTURE OF BRACKETS ON 8-IN. COLUMNS, XVI. AND XVI.

signal department are the same. On nearly all roads, the development of the signal department has been slow, the first few signals installed being cared for by some one of the larger departments, usually that of the chief engineer. As the equipment each year increased (and sometimes very rapidly) it soon became necessary to assign to the work men who would do nothing else than keep the signals in repair, any expert opinion in regard to signaling or apparatus, being given by the signal companies active in introducing their several devices. This, however, soon proved unsatisfactory, and the numerous questions that arose which could not be referred to the signal companies for their opinion, practically compelled the railways to appoint some one who would be capable of giving an expert opinion on these subjects, and who would also take charge of the signal repairmen.

With such a beginning it would naturally follow that the organization of the force and the department to which the men were assigned, would be different on nearly every road. In other words, the signal engineer might be made to report to the chief engineer, the superintendent of bridges and buildings, the superintendent of motive power, or one of the operating officials, according to the particular department that the work had first been placed under. In several instances, the different branches of signal work were di-

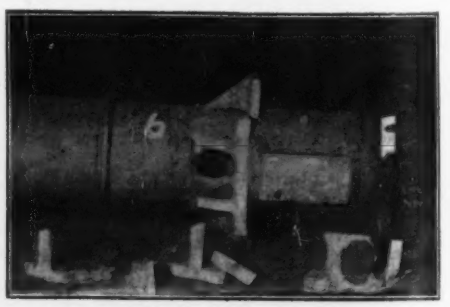


Fig. 14.—Fracture of Brackets on 15-in. Column, No. 6.

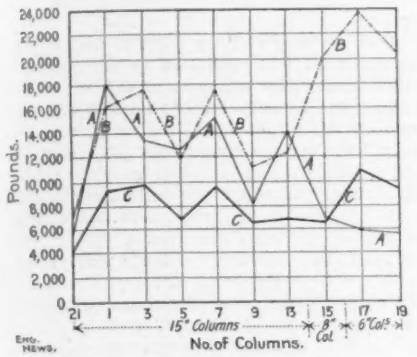
vided among several departments, the electric signals being looked after by the telegraph department, block signals by the bridge and building department or some operating official, and the interlocking work by the chief engineer's department.

Taking it for granted that the signal work on the road is sufficiently large to put a man in charge with some sort of title, the principal factors in determining the status of this individual are as follows: (1), The official to whom he will report; (2), The organization of the force for the proper maintenance of the several signal systems. The organization of the force has to do with, (A), The disposition of the force for the making of repairs, and (B), The consequent cost of doing the work; the one relating solely to the number of men employed, and the other being the proof of the excellence of the system, or the standard whereby the efficiency of the organization is to be measured.

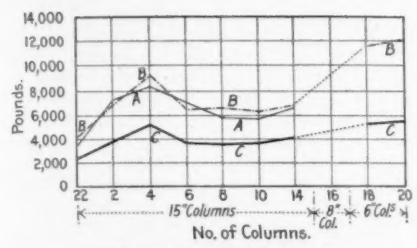
In considering the question of the proper official for the

*Abstract of a paper presented at the meeting of the Railway Signaling Club, held at Chicago, Jan. 11.
**Signal Engineer; C., M. & St. P. Ry.

signal engineer to report to, the principal point is to reduce, as far as possible, the number of persons through whom his orders will come and to bring him in direct contact with the operating official who is most concerned in the efficient work of the several systems of signals. On most roads this is the general superintendent, who, from the fact that he is charged with the proper operation of the road should be the one who has the most to say as to where the signals are most needed, and to decide what system of signals shall be used.


Pounds.
No. of Columns.
15" Columns
8" Col.
6" Col's
A = Breaking Load per sq. in. of Actual Fractured Area, Measured above the Plane of Bottom of Shelf.
B = Breaking Load per sq. in. of Vertical Section through Shelf.
C = " " " " " Total Vertical Section.

Test with Load at End of Bracket.



Test with Distributed Load.

FIG. 16.—DIAGRAM SHOWING STRENGTH OF BRACKETS ON CAST-IRON COLUMNS AS INDICATED BY THE TESTS.

That this plan will work out well can hardly be denied in view of the many cases where it is in satisfactory operation, while from the signal engineer's standpoint it is very much to be desired, as it makes of his forces a separate department and places him in direct responsibility for everything concerning the work of that department. With the signal engineer reporting to one of the other officials, he must get his orders from one not immediately concerned as to the efficient working of the signal systems, in regard to the movement of trains and one who, in many cases, approves plans and signs requisitions without really looking into the subject as it deserves. With the signal engineer doing all of his business with the superintendent, and receiving his orders from an official other than the superintendent, either the efficiency of the arrangement will not be what it should be (owing to the signal engineer receiving orders at second-hand), or else the system will degenerate into a mere matter of form, the signal engineer being the actual head without the responsibility.

In the maintenance of an interlocking plant, a great difficulty which the signal engineer has to contend is the kind of men that are usually put in to operate the plant. Most of these men have had no mechanical experience and are usually very slow in picking up a knowledge of what is the proper thing to do in case of accident or derangement of the parts of the plant. They are not, as a rule, hired by the signal engineer and will often try to shift responsibility to the signal department for any accident that may occur. If they do not take an interest in the mechanical construction of the plant, they often occasion unnecessary delay to trains by not knowing where to look for the cause of trouble when anything is wrong with the plant. This is particularly the case with plants having electric locking or where there are very long pipe lines. The remedy for this state of things is to put the control of the towerman under the signal engineer, as he can then see to it that the right men are employed, and that they look after and work the plant in a proper manner. This is especially necessary where the signals are wire-connected, for with the long wire line to the distant signal no amount of adjustment can make the blade come down to the proper position, unless the lever is pulled with energy or "snap."

Another question of vital interest to the signal engineer is the assignment to his department of the care and maintenance of all signal work on the road. While this is the general custom, there are many roads where the different branches of signal work are divided among several departments: electric signals being cared for by the telegraph department; block signals by the building department, and interlocking and switch signal work by the signal department. This plan is defective in the matter of expense of maintenance, and in the lack of expert supervision and care which the signal systems at the present day require.

With the signal system all cared for by one department fewer men will be needed to keep them in repair and the proper relations of one system with another will be maintained in a more satisfactory manner. Proper specifications will more certainly be gotten out and standards maintained, and no opportunity will present itself for a of responsibility by the department in charge. There will be no doubt on the part of the superintendent, or other official, as to which department is to be referred to regarding a certain piece of work, or who is to be called on when the signals need attention.

A NEW BUILDING CODE FOR NEW YORK CITY.

A meeting of organizations interested in the formation of a new Building Code for the city of New York was held at the Builders' League, 74 West 126th St., Jan. 13. The societies or organizations represented were: The City Fire Department, Board of Trade, Real Estate Exchange, Mechanics' and Traders' Exchange, North Side Board of Trade, Building Trades' Club, Architectural Iron Manufacturers, Builders' League, Mason Builders' Association and the Master Plumbers' Association. In all, some 17 delegates responded to the roll call, and letters from two or three other organizations asked to join were read. Among the latter was one from the Architectural League of New York, regretting its inability to take active part in the proceedings, and asking that a committee be sent to attend a meeting to be held under the auspices of the League at the Art League Bldg. Jan. 19 at 4:30 p. m. for the consideration of the same subject.

The chairman of the meeting, Mr. Wm. J. Fryer, stated that, to his mind, the letter indicated a disinclination on the part of the League to enter the present organization, and the intention of starting an independent movement. It was stated that the Architectural League had taken up the subject of revision of the building laws some time previous, and that naturally they would continue their efforts. After considerable discussion, it was decided to accept their invitation and send a committee to see what the League was doing or intended to do.

As the first step in the formation of a new building code would be the selection of a committee of experts, as specified in the new charter, it was considered advisable by some that this meeting of delegates at once submit names of men to form a list from which the experts might be selected. If this were not done other organizations might get their lists in ahead. This opinion was affirmed by the chairman, who said that the first object of the present organization was to prepare a list of eligible men and say to the Municipal Assembly, "Choose from these." At this point the delegate from the New York Board of Trade stated that his presence at the meeting was due to a desire on the part of the Board of Trade to have the height of buildings limited. Some discussion on this subject then followed, after which the objects of the meeting and a suitable name for the contemplated organization were considered. "The Joint Committee on New Building Code" was finally adopted as the name, and at the request of several of the delegates Mr. Fryer left the chair and stated the object of the committee, which they had formed, as follows:

1.—The committee shall urge upon the Municipal Assembly the necessity and importance of a new building code.

2.—The committee shall prepare and present a list of names from which the Assembly shall be urged to select the experts to draft the new code.

3.—After such commission of experts is appointed, the committee shall make such suggestions and recommendations as it considers advisable.

By this time several of the delegates had left, among them the representative of the Master Plumbers' Association.

Attention was called to the fact that Engineerng News, in its issue of Jan. 13, had stated that the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Society of Heating and Ventilating Engineers had not been invited to attend the meeting. Mr. G. A. Just, M. Am. Soc. C. E., stated that as the American Society of Civil Engineers was a national society it was naturally very conservative and not likely to take part in a matter of local interest only. In discussing this subject, the chairman said that the American Society of Civil Engineers had been invited, but that he failed to see how the Master Plumbers' Association, the Society of Civil Engineers, the Society of Mechanical Engineers or the Society of Heating and Ventilating Engineers could have any interest in the formation of a new building code, and that as all electrical matters were under the Fire Department, the Institute of Electrical Engineers could have no interest.

It was then decided to send a statement of the objects of the joint committee, as already given, to each society then represented or previously invited to attend the meeting and signifying its intention of joining the movement.

At this point attention was called to the fact that the invitation sent to the American Society of Civil Engineers had been sent so late that a reply could hardly be expected in time, and that the American Society of Mechanical Engineers, the Institute of Electrical Engineers, the Society of Heating and Ventilating Engineers, the Brooklyn societies and none of the individual consulting engineers or architects of Greater New York had been invited. After some discussion, the motion was altered and the secretary was instructed to invite the societies mentioned and all other societies, organizations or individuals likely to be interested in a new building code to attend the next meeting, which will be held Jan. 27 at the same place and hour.

CLAY AS A BINDER IN STONE ROAD CONSTRUCTION.

In the January Proceedings of the Engineers' Club of Philadelphia, Mr. Benjamin Franklin contributes a paper dealing largely with the use of clay as a "binder" on stone roads. The specifications for macadamized road construction in use by the State of New Jersey, the City of Philadelphia and of many towns in Pennsylvania and neighboring states, permit the use of clay, gravel and loam for building purposes. French engineers are also stated to use clay for this purpose in proportions varying from 20 to 60%. Mr. Franklin believes that this clay possesses two prominent disadvantages. It is a lubricant, reducing the friction between the stones; and it absorbs a large percentage of moisture, and changes in bulk and consistency under varying weather conditions. It is a good adulterant and tends to a reduction of the amount of good stone material; and he believes that with its use a road rapidly deteriorates; has a tendency to rut; is more easily affected by frost, and the foundation is made unstable, in wet weather, by the percolation of moisture.

In discussing this paper, Mr. Thomas G. Janvier, differed from Mr. Franklin in regard to the use of clay as a binder. From practical experience, Mr. Janvier found that the clay, properly put on, made a better road. He mentioned a road built in Delaware Co., in 1888. On an 8-in. Telford foundation was a 4-in. layer of broken stone; and on this last was put a light sprinkling of clay. The whole was then thoroughly rolled. The finishing coat was about 1 in. of coarse screenings, sprinkled and rolled until the surface was hard and smooth. This road lasted about nine years without any repairs. The surface was much worn down; but the wear was even, scarcely a rut appeared, and the road was still in good condition. Within the last year 3 ins. of ¾-in. broken stone was placed upon it, without picking up the original surface, which was as hard as iron, and on top of this was spread a light coat of clay and stone dust.

Mr. Janvier contended that just enough clay to bind the two top sizes of stone was advantageous. A smooth road cannot be secured with ¾-in. stone alone as a top dressing; and it cannot be compacted or smoothed by rolling. But a light coat of clay applied on the ¾-in. stone, and this then covered by ½ to ¾-in. of pure stone dirt, could be rolled and resulted in an excellent road. A 15-ton roller was employed, and the road was kept well sprinkled for some time after completion. But, says Mr. Janvier, the clay must be used very judiciously and the contractor must be closely watched.

The specifications for this road referred to, demanded that the foundation stone should be hard, tough and durable. For the broken stone trap rock was preferred. The cost of this road, with 8-in. foundation covered by 4 ins. of broken trap rock, was 65 cts. per sq. yd. The grade from crown to gutter was 3 and 4%, and the earth bed was rolled before the foundation was put in. Mr. Janvier preferred the Telford to the Macadam type of construction, as being more durable and less liable to rut than the latter. Constant daily attention in the matter of repairs, said Mr. Janvier, is cheapest in the long run, and the judicious use of the water-cart will add materially to the life of the road.

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Elsewhere in this issue will be found an account of an effort on the part of several local builders' organizations to bring about a revision of the building code at present in operation in New York city.

It is conceded on all hands that there are many details in the present building laws requiring modification if not complete change. As an example, we need only mention the matter of cast-iron columns which, under the present law are permitted to carry heavier unit loads than steel columns. Admitting, then, that a new building code is desirable or essential, how is its preparation and adoption to be brought about?

Chapter XII., Sec. 647, of the new charter, gives the Municipal Assembly the power to appoint a commission of experts who shall formulate a new code, and until the adoption of such new code the several sets of local building laws continue in force as before consolidation. Elsewhere in the charter (Chap. II., section 47), the assembly is given the power to amend from time to time the building laws, but it is explicitly stated that all such amendments must be prepared by the Building Department. The assembly must approve or reject what the Department originates and proposes, and cannot amend or alter it.

The wisdom is manifest of placing the responsibility of formulating the code and amendments thereto upon experts, instead of upon the assemblymen, who naturally know nothing of the technicalities of engineering or architecture. But it is equally evident that the excellence or the reverse of the new code will depend very much on the character and ability of the men who formulate it. The opportunities for favoring one industry at the expense of another, are enormous, and there are few questions of greater practical importance before New York city to-day, than the question of securing the right men to formulate a new building code. As told elsewhere in more detail, several local organizations of builders, contractors and others are already arranging to press this matter upon the assembly's attention, and, presumably, secure the appointment of experts of their own nomination. The architects are engaged in an independent movement on the same lines. Is not this matter of sufficient importance to the members of the engineering societies so that these, too, should exert a direct influence in the nomination of experts for this important work. It is true that these societies are of national scope; while this is from one point of view a local matter; but it is to be remembered that New York's code will be taken as a model to a large extent by other cities; further, hundreds of establishments whose managers are members of the engineering societies may be directly affected by the restrictions that may be introduced in a new building code.

We see no reason to criticise the organizations which are taking care that the interest of their members shall be protected in the preparation of a new building code. They have shown a commendable spirit in inviting the engineering societies to take part in their deliberations. If these organizations decide to neglect this opportunity, their members need not complain in future of crudities or injustice in the building law. Their opportunity to make their influence felt is now. Will they take advantage of it?

The Rapid Transit situation in New York city has been subject to so many kaleidoscopic changes during the past fortnight, that without inside information as to the deals and understandings between the various parties in interest, it is difficult to say just what the present status really is. The most important recent events may be summarized in the order of their sequence as follows:

1. Mayor Van Wyck says in his inaugural message that New York is too poor to build the Rapid Transit railway, and that the Manhattan Elevated Ry. should be "compelled" to equip its lines with electric traction and to build extensions to the ferries and to the districts beyond the Harlem River.
2. President Gould, of the Manhattan Company, announces that his corporation has decided to make the improvements recommended by the Mayor.
3. The Metropolitan Transit Co., which had been preparing to bid for the rapid transit franchise withdraws from the field.
4. The Rapid Transit Commission announces that until it is known what the Manhattan Co. will or will not do, it is useless to expect bidders for the Rapid Transit franchise.

So much the public knows; but there are many things that it doesn't know. Is the Manhattan company in earnest, or is it merely bluffing again, and playing dog in the manger? We think it quite likely that it is in earnest. The change to electric traction would cost a large sum; but the increased traffic and reduced operating expenses which would result would probably pay a handsome interest on the investment. There is no question that the change would be of great benefit to the public which uses the road and the property-owners in the streets through which it runs. The proposed extensions, too, would in all probability, prove profitable, and if the company is willing to undertake them on proper terms, we have no doubt they would be approved by the Rapid Transit Commission. This approval is apparently necessary to the making of such extension; and it is also probable that under the new charter the company's franchise for any such extension would be limited to 25 years in any event.

As for the talk of "compelling" the Manhattan to build extensions or change its motive power, the Rapid Transit Commission very pertinently says:

> The board has thus far proceeded upon the assumption that it had no power to compel the elevated railway company or any other railroad company operating within the city to extend its lines or to give to the public facilities not required by its present charter. To make sure, however, the committee has asked the counsel of the board for an opinion upon the subject. They have replied that the board has no such coercive power whatever; that, so far as they have been able to ascertain, no authority of the city has any such power; and that it is extremely doubtful whether there be constitutional power by new legislation to compel an existing corporation against its will to invest its funds in extension of its railway or to accept and use a new railroad franchise.

It would appear to disinterested observers that an amicable arrangement has been effected between all the various parties in control of the city's transit interests, with the object of defeating the Rapid Transit enterprise and securing whatever political and pecuniary profit is to be made by the extension of New York's transit facilities. It is to be sincerely hoped that in this deal the interests of the public and of the stockholders of the various corporations may be as well served as will be the interests of the players in the game.

What to do with the signal department is a question which is of considerable importance on a good many railways; and it is discussed on another page of this issue by Mr. W. H. Elliott, of the Chicago, Milwaukee & St. Paul. He advocates making it an independent department, with its head reporting directly to the General Superintendent. On a large road with a competent signal engineer in charge of work, there can be little doubt that this is a wise plan. One good reason to justify it is that the superintendents and managers have given more attention to signaling than any other class of railway officers, and are generally quite as well qualified to pass upon the work of their signal engineer, as are any of their subordinates. But while this plan will very likely prevail on the larger roads the small roads frequently feel that the employment of a competent signal engineer is beyond their means. On such roads, the superintendent will either himself supervise the towermen and repairmen, or will turn them over to the chief engineer.

The need that the higher officials shall keep in close touch with signaling development is illustrated by the description of the new interlocking plant near Hammond, Ind., illustrated in this issue. Nearly a dozen different railways have tracks which intersect at this place; and it was attempted to settle on standards for construction which should be uniform for the entire plant. The attempt, however, was a failure. One road required bolt locks to be placed with the bolt or plunger on top of its bed plate, while another required the same device to be placed in an inverted position. One road provides its switch point connections with no less than three screws for adjustment, while another allows no adjustment, requiring that the switch shall be put up properly in the first place and the track then kept in proper condition so that adjustments will not be necessary. But the most important difference is in the semaphore signals, of which there are about 60. One road has adopted a form of casting which will allow the blade to drop to a vertical position, while another has adopted a form which drops the blade to an inclined position, both indicating a clear track, and each road has required its own adopted appliances to be used at this plant. Consequently, we see in this plant, semaphore blades horizontal, inclined and vertical, and an engineman accustomed to the latter position for "clear" might suppose an inclined arm to be defective. Further than this, two systems of color for the semaphores are in use at this plant. Those for one road have the running faces painted yellow with a black stripe, while the others have them painted red, with a white stripe, the latter being by far the most general practice. While it is true that the trains of each principal road will be almost invariably run on the tracks fitted with the signals adopted by that road, yet it is readily conceivable that it may sometimes be necessary to change the routes so that the engineman will have to be guided by signals differing from those to which they are accustomed. This use of two systems at one point involves unnecessary complication and is objectionable in that it weakens the idea of a uniform significance for railway signals which ought to be impressed upon every engineman and trainman. In another case to which our attention has been called, two tracks, owned by different roads, cross a single track, and each road has required its special system to be odapted. The result is that on one of the lines an engineman going in one direction is governed by a yellow blade, while on returning he is governed by a red blade.

Such examples bring out forcibly the evils which result from failure to adhere to standard practice in signaling work. There is hardly a department of railway service, unless it is freight car construction, where "pet ideas," a little different from other people's, are more out of place.

The summary of the exports of breadstuffs, cotton, provisions and mineral oils for 1897, just issued by the Bureau of Statistics, contains figures which enable an interesting comparison to be made of the export trade of the principal ports. We have compiled the following table, in which the exports from each of these ports of the above articles are summarized:

Value of Exports, 1897 (in Thousands of Dollars).

Ports.	Breadstuffs.	Mineral oils.	Cotton.	Provisions.
New York	69,995	32,606	7,768	79,275
Baltimore	40,903	2,827	2,687	20,360
New Orleans	19,927	.....	29,561	1,747
Boston	19,217	112	3,913	53,395
Philadelphia	16,253	19,159	282	6,441
Newport News	14,420	.....	161	.....
Norfolk & P'rtsmouth	5,535	.....	1,762	.....
Galveston	8,270	.....	30,787	.....
San Francisco	21,051	.....	719	672
Puget Sound	6,036	.....	1,221	.....
Willamette	8,028	.....	.....	.....
Duluth	2,153	.....	.....	.....
Superior	2,946	.....	.....	.....
Other customs dists.	8,387	4,352	.....	.....
Total	243,121	59,058	118,736	171,524

The above list includes live cattle and hogs under the head of "Provisions," and all classes of grain exported are included under the head of breadstuffs. The articles named constituted in 1896 about two-thirds of our total exports.

It will be seen that New York's exports of the above staples amounted in round numbers to 190 million dollars. Boston and Charleston came next with a total of 76 millions and then follow Baltimore with 67 millions, New Orleans with 57 millions, Philadelphia with 42 millions and Galveston with 39 millions.

The two ports whose growth is most noticeable are Baltimore and Galveston. In 1890 the total exports from Galveston were only 24 million dollars. With the increased depth of water at that port, and the improvement in the railway and terminal facilities, a still larger proportion of the products of the grain growing states west of the Mississippi will probably seek an outlet there. Baltimore is generally conceded to be New York's most dangerous competitor in the grain trade. In corn shipments last year, New York had to take second place, with a total of only 33,000,000 bushels, compared with 43,000,000 from Baltimore. It is true that New York gained 14,000,000 bushels in its corn export over 1896; but Baltimore gained 17,000,000 bushels. Philadelphia, notwithstanding her comparatively low place, exported nearly double the grain and breadstuffs in 1897 that she did in 1896. In exports of live cattle, Boston leads New York by a very small margin.

One influential factor in aiding the Chesapeake Bay ports is that vessels sailing from them during the winter months are allowed to load more deeply than vessels sailing from Philadelphia or ports north. It is stated that the difference may amount to as much as $1,500 in the freight earnings of a steamer on a single voyage. An effort is being made to have this restriction removed. Whether it should be removed or not appears to depend on the question of just whether ships clearing from Chesapeake Bay ports do take a more southerly route to cross the Atlantic than ships sailing from New York or Philadelphia; and testimony on this point is conflicting.

In our opinion a more important reason for the growth of grain exports from Baltimore and Philadelphia is the steadily lowering in the cost of all-rail shipments to the seaboard. It was recently reported that grain was to be carried all-rail from Chicago to tidewater for 6 cts. per bushel. Calling the distance to the ports on Chesapeake or Delaware bays 800 miles, this is equivalent to only 3 mills per ton mile; but on large shipments, which can be hauled in solid train loads from terminal to terminal, it is quite safe to say that the railways are not handling the traffic at a loss. Of course, at such a figure the advantage of the lake and rail or the lake and canal route is reduced to a very small amount, and it takes but a trifle of added expense in elevator transfers and port delays at Buffalo and New York to make the balance even, as respects the actual freight cost. In such a case the advantage to the shipper of sending by rail will be apt to turn the traffic toward the more southern ports.

THE STRENGTH OF CAST-IRON COLUMNS.

The experiments upon cast-iron columns, made by the New York City Building Department upon the large testing machine at Phoenixville, Pa., a full report of which was given in our last issue, are, we believe, the most important tests of cast-iron columns which have ever been made. The results are of especial importance in that they show the utter worthlessness of Gordon's formula, and of the coefficient commonly used in this formula, as applied to cast-iron columns, and the grave defect in the New York Building Law, which especially directs the use of this formula and of the coefficient 80,000 in computing the strength of columns and posts.

As was stated in last week's issue, the 15-in. columns tested at Phoenixville would be calculated by the formula to have a breaking strength of 57,143 lbs. per sq. in., while the actual tests showed that their strength was only from 24,900 lbs. to something over 40,400 lbs. per sq. in. The 6-in. and 8-in. columns would be calculated to have a breaking strength of 40,000 lbs. per sq. in., while their actual breaking strength was only from 22,000 to 31,900 lbs. per sq. in.

The treacherous nature of cast-iron columns has been known to engineers for many years. They have been adandoned in bridge construction ever since the memorable Ashtabula bridge disaster, December 29, 1876, and they have been considered to be the probable cause of the fall of tall buildings in New York city, notably the Ireland building and the Brown soap factory (Engineering News, August 15, 1895, and June 17, 1897). In an editorial note concerning the failure of the Ireland building in our issue of August 15, 1895, we said:

> The only excuse for the use of cast-iron columns is that they are cheaper—though very little cheaper—than steel columns. It is high time that the law made the use of such columns in tall buildings impossible. There are other buildings with cast-iron columns now in course of erection in New York city, larger and taller than the one which has just failed. Perhaps, it is not too late yet for the Building Department to inspect these columns for thickness and for blowholes, or even to compel their removal on the ground of public safety, and the substitution of steel columns.

The law still remains, and buildings with cast-iron columns are still going up, but the Building Department has taken one step in advance of its position in 1895, it has tested two of the actual columns used in the Ireland building, with eight others, and has now some data from which a formula for proportioning such columns may be made, which will be far nearer to being accurate than is Gordon's or any other formula based upon Eaton Hodgkinson's experiments of about 60 years ago.

It is of interest in this connection to go back to Hodgkinson's experiments themselves, and find what basis they give for designing columns for large buildings: It will probably surprise most of our readers to know that the only basis upon which is constructed the formula for hollow cast-iron column variously known as Gordon's and as Rankine's, with its different coefficients as given by different writers, and upon which are designed all the columns used for buildings in New York city, is a series of experiments by Hodgkinson on nine "long" pillars, 7½ ft. long, whose external diameters ranged from 1.74 to 2.23 ins., and whose greatest thickness was 0.35 in., and on 13 "short" pillars, 0.733 ft. to 2.521 ft. long, with external diameters from 1.08 to 1.26 ins., and whose thickness was in no case as great as ¼-in. The strength per square inch of a piece of cast iron varying with its fineness of grain, which depends on its thickness and rate of cooling as well as on its composition, it is not possible to predict from the strength of a piece ¼-in. thick what will be the strength of a piece of the same iron 1 to 1 3-16 ins. thick, the thickness used in modern 15-in. columns. How then is it possible to get from Hodgkinson's experiments any reasonable formula for dimensioning columns of the size and thickness now used in buildings?

TABLE I.—Hodgkinson's Experiments on Hollow Cylindrical Pillars, Flat at the Ends. (Low Moor No. 3.)

No.	Length, ft.	Length, ins.	Diameter, Exter.	Diameter, Inter.	Weight, lbs.	Breaking weight, lbs.	Value of x.*
1.	7	4¾	1.78	1.21	31	17,840	2.974
2.	7	4¾	1.74	1.187	30¼	16,705	3.031
3.	7	6¾	1.76	1.18	..	16,745	2.969
4.	7	6¾	1.75	1.11	32	20,957	3.587
5.	7	4¾	2.04	1.46	35¼	32,413	3.574
6.	7	6¾	2.01	1.368	37¾	30,789	3.290
7.	7	4¾	2.01	1.415	36½	28,353	3.214
8.	7	5¾	1.99	1.31	39	27,067	2.988
9.	7	4¾	2.23	1.54	47	40,569	3.099
10.	7	6¾	1.76	Solid.	56	23,179	3.115
11.	7	6¾	1.72	Solid.	53½	21,995	3.208

No. 10 was cast in green sand; No. 11 in dry sand.

*Value of x in the formula

$$x = \frac{W}{D^{3.55} - d^{3.55}}.$$

The value is the strength of a solid pillar 1-in. diameter and of the same length as those above.

Mr. Hodgkinson made three series of tests of hollow columns, the first of 19 columns with hemispherical caps in their ends so as to give a bearing in the center. The largest of these columns was only 3.36 ins. in diameter. As these columns had "rounded ends," and as their strength was less than one-third, on the average, of columns of similar dimensions with flat sides, this series of tests may be neglected in this connection, and it does not enter into the construction of the formula for flat-ended columns. The second and third series we reproduce herewith from Hodgkinson's tables:

TABLE II.—Hodgkinson's Experiments in Short Hollow Cylinders, with their Real and Calculated Breaking Weights for Comparison. (The ends are flat, and the lengths less than 30 times the external diameter.)

No.	Length, ft.	Diameter, Exterior, ins.	Diameter, Interior, in.	Breaking weight, lbs.	Value of b.	Value of c.	Calcltd breaking weight.
1.	2.521	1.26	.767	33,679	38,807	86,178	32.331
2.	2.521	1.26	.781	32,867	38,274	84 310	31.790
3	2.167	1.25	.768	35,302	48,461	83 882	36.501
4.	2.167	1.17	.752	31,195	36,880	69,283	28.764
5.	1.917	1.16	.771	30,383	42,633	64,844	30.291
6.	1.681	1.21	.77	41.751	64,589	75.130	40,128
7.	1.681	1.14	.805	27.135	46,408	56.193	29.449
8	1.417	1.15	.91	25,511	50,927	42,636	26.191
9	1.333	1.15	.92	25,105	54,730	41,053	26.273
10.	1.260	1.16	.932	26,729	61,304	41,133	27.364
11.	1.260	1.08	.77	27,135	61,570	41,133	27.364
12.	1.167	1.15	.792	37,285	91,909	59.953	40.257
13.	.733	1.13	.91	34,037	133,000	38 704	31 750

By the value b is understood the breaking weight calculated from the formula

$$b = 99{,}318 \frac{D^{3.55} - d^{3.55}}{l^{1.7}}$$

for the strength of long pillars in pounds. The value of c is the force which would crush the pillar without flexure.

Mr. Hodgkinson's experiments were first published in the Philosophical Transactions of the Royal Society, Part II., 1840, and are given in condensed form in his "Experimental Researches on Strength and other Properties of Cast Iron," which formed the second part of the fourth edition of Tredgold's "Practical Essays on Strength of Cast Iron and Other Metals"; this was published in 1846. We quote some of his remarks on the experiments below:

> (P. 330.) With a view to develop the laws connecting the strength of cast-iron pillars with their dimensions, they were broken of various lengths from 5 ft. to 1 in. and their diameters varied from ½-in to 2 ins. in solid pillars, and in hollow ones the length was increased to 7 ft. 6 ins. and the diameter to 3½ ins. My first object was to supply the deficiencies of Euler's theory for the strength of pillars (Academié de Berlin, 1757) if it should appear capable of being rendered practically useful, and if not, to endeavor to adapt experiments so as to lead to useful conclusions.
>
> It was desirable that all the pillars of cast-iron should be from one species of metal and the description chosen was a Yorkshire iron, Low Moor, No. 3, which is a good iron, not very hard and differs not widely from that called No. 2. (Earlier experiments (see p. 334) give the tensile strength of No. 3 Low Moor cold-blast iron as 14,535 lbs. per sq. in., and crushing strength at 109,801 lbs.)

After discussing the results of experiments on solid pillars he continues:

> In hollow pillars nearly the same laws were found to obtain (as in the cast of solid pillars). Thus, if D and d be the external and internal diameters of a cast-iron pillar whose length is l, the strength of a hollow pillar of which the ends are moveable (as is the connecting rod of a steam engine) would be expressed by the formula below, where l is in feet, and D and d are in inches.
>
> $$\text{Strength in tons} = 13 \times \frac{D^{3.6} - d^{3.6}}{l^{1.7}}.$$
>
> In hollow pillars whose ends are flat and firmly fixed by disks or otherwise, I found from the results of numerous experiments as before,
>
> $$\text{Strength in tons} = 44.3 \frac{D^{3.6} - d^{3.6}}{l^{1.7}}.$$
>
> (The tons are of 2,240 lbs.)
>
> The 13 is a mean obtained from 19 experiments from hollow pillars with rounded caps upon the ends to make them movable there like solid ones with rounded ends. This number is too low as some of the best hollow pillars were bad castings. The 44.3 on those with flat ends was obtained from 11 pillars, taking pillars only whose length was more than 25 times the external diameter, as in solid ones.
>
> The formulae for hollow pillars are obtained by adapting the results of Euler's theory to those of experiment and were found to answer well when so altered. According to that theory the strength varies as $\frac{D^4 - d^4}{l^2}$.
>
> Strength of Short Flexible Pillars.—The formulae above apply to all pillars whose length is not less than about 30 times the external diameter of the pillars. Shorter than this is will be necessary to modify the formulae by other considerations, since, in these shorter pillars the breaking weight is a considerable proportion of that necessary to crush the pillars.
>
> Thus, considering the pillars to have two functions, one to support the weight, and the other to resist flexure, it follows that when the material is incompressible (supposing such to exist) or when the pressure necessary to break the pillar is very small on account of the greatness of its length compared with its lateral dimensions, then the strength of the whole transverse section of the pillar will be employed in resisting flexure.

Mr. Hodgkinson continues this method of reason-

ing to some extent further, and arrives at the following formula for short pillars:

$$y = \frac{b\,c}{b + \frac{3\,c}{4}}$$

in which

c = the force which would crush the pillar without flexure,
b = the breaking weight as calculated for the preceding formulae for long pillars,
y = the real breaking weight.

In the "values of x" in Table I., it will be seen that the strength of columns made from the same iron and of almost identical dimensions varies in the ratio of 2,969 to 3,587, or over 12%. How much it would differ with different irons and different dimensions can be conjectured.

In Table II., the "value of b" calculated from the formula for long columns ranges from 15% greater to nearly 300% greater than the actual breaking strength, the difference increasing as the column is shorter. Hodgkinson himself made a different formula for what he called "short" columns; that is, whose length is less than 30 times their diameter, because he found that the long column formula gave wrong results for short columns, but Gordon's formula is for long columns, and the New York Building Law specifies it for the proportioning of "all columns and posts," whether long or short. The columns tested at Phoenixville, and most of those used in building in New York city are all "short" columns. The 15-in. columns tested at Phoenixville were only 13 diameters in length, and the 6-in. and 8-in. columns only 20 diameters.

While, as we have stated, the tests made at Phoenixville appear to be the most important tests of cast-iron columns that have ever been made, they are not the only ones on record which may be used to show that no satisfactory formula can be deduced from Hodgkinson's experiments in slender cast-iron pipes which is applicable to the heavy columns now used. Tests of some cast-iron mill columns were made on the Watertown testing machine in 1887 and 1888, from which the same conclusions may be drawn.

Professor Gaetano Lanza in his "Applied Mechanics," page 372, gives the records of these tests as follows:

Minimum sectional area, sq. ins.	Breaking weight, lbs. per sq. in.	Minimum sectional area, sq. ins.	Breaking weight, lbs. per sq. in.
13.19	38,880	5.19	31,850
12.27	43,350	5.27	29,960
12.08	33,500	5.50	33,350
11.75	26,840	10.92	32,130
11.89	30,370	21.75	25,470
11.80	29,830	17.28	27,210
8.94	63,310	13.22	25,100

Professor Lanza says concerning these results:

A glance at the table will make it evident that, in the case of such columns, we cannot rely upon a crushing strength of greater than 25,000 or 30,000 lbs. per sq. in. of area of section. Hence it would seem to the writer that, in order to proportion a cast-iron column to bear a certain load in a building, we should first compute the greatest load that can come upon the column, and, dividing this by 5,000, which would correspond to a factor of safety of between 5 and 6, obtain an area of section which might probably be adopted, provided it proves itself sufficient for the other requirements which follow here. Next determine the outside diameter in such a way as to avoid an excessive ratio of length to diameter; if this ratio is not much in excess of 20 the extra strength produced by any eccentricity of the load due to the deflection of a column will be very slight. At the same time see that the thickness of the metal is such as to insure a good strong casting.

Now, having figured the columns in this way, compute the outside fiber stress that would occur with the loading of the floors assumed to be such as to give as great an eccentricity as it is possible to bring upon the column. If this distribution of the load is one that is likely to occur, then the maximum fiber stress in the column due to it ought not to be greatly in excess of 5,000 lbs. per sq. in., but, if it is one which there is scarcely a chance of realizing, then the maximum fiber stress on it might be allowed to reach 10,000 lbs. per sq. in. If, by adopting the dimensions already chosen, these results can be obtained we may adopt them, but if it is necessary to increase the sectional area in order to accomplish this, then we should increase it.

We commend Prof. Lanza's words to the attention of all architects and engineers who may have anything to do with the design and use of cast-iron columns. We also commend them to the attention of the New York city Building Department, and to those gentlemen who are planning to take part in compiling a new building law. If Prof. Lanza's rule for proportioning columns could be inserted in the law, it would be vastly better than Gordon's, and buildings using columns proportioned by his rule might be considered reasonably safe, provided the castings were well made, of iron of fairly good quality. But if such a rule were adopted, cast-iron columns would quickly go out of fashion, for then they would be dearer than steel columns. Such a result is one greatly to be desired.

LETTERS TO THE EDITOR.

Tests of Cast-Iron Pipe for Chicago.

Sir: As certain false and malicious rumors, intended to injure us, have been circulated regarding the efficiency and integrity of the services rendered by us as inspectors of 35,000 tons of cast-iron pipe, being made by the Addyston Pipe & Steel Co. for the city of Chicago, and wide publicity has been given to the statement that six pieces of 36-in. pipe has been rejected after delivery, we requested th Commissioner of Public Works and the City Engineer of Chicago to thoroughly investigate the matter. After such investigation, the City Engineer, Mr. John Ericson, has reported to the Commissioner of Public Works, Mr. L. E. McGann, that the Pittsburgh Testing Laboratory, Ltd., have performed their duties in a satisfactory manner; and, further, that there is no cause for the rejection of any pipes previously accepted by their inspectors, except those broken in transit and handling. We make this statement desiring to correct any false impressions which may have been created by these reports.

Yours truly,
Pittsburgh Testing Laboratory, Ltd.,
T. L. Condron, Resident Engineer.

1750 Monadnock Block, Chicago, Ill., Dec. 31, 1897.

Things That Are Not New.

Sir: The "New Sectional Gun," as described and illustrated on p. 414 of your issue of Dec. 23, 1897, is substantially the same as one designed by Ericsson, of "Monitor" fame, about 1862, which was, at the time constructed, tested by the United States Ordnance officers and "found wanting." About ten years afterward Mr. N. Thompson patented a gun on a similar design and interested New York capitalists in a project for its construction, which, upon advice from the writer, was not carried out. The reasons given by him, which are applicable to the design first mentioned, as well as to the two others, will be apparent upon inspection of the illustrations accompanying the article printed.

An instrument like "The Eophone," described and illustrated on p. 10 of your journal, Jan. 6, 1898, and essentially as there shown, was invented by the lamented Dr. Alfred F. Mayer, Professor of Physics, Stevens Institute, several years ago. The time when he presented it to the United States government authorities for examination was not ripe for its introduction.

"There is nothing new under the sun."

New York, Jan. 11, 1898. Old Fellow.

Credit to Whom Credit is Due.

Sir: The verses printed in your issue of Dec. 30, entitled "The Engineer," were written by me. I make this statement in justice to the reputation of Mr. Chester T. Dike, City Engineer of Mason City, Ia., to whom you are indebted for a "pamphlet" containing the lines. Mr. Dike, no doubt, will feel kindly towards me for assuming the authorship of a crime which (from a hurried reading of your apology for its publication) might point to him as the culprit.

The poem (?) was written last May at Corning, N. Y., where our company was engaged constructing an extensive system of levees for protection against floods in the Chemung River. My friend, Palmer C. Ricketts, M. Am. Soc. C. E. and Director of the Rensselaer Polytechnic Institute, was Chief Engineer in charge of the work, and he, together with his efficient Assistant Engineer, are responsible for the birth of the rhyme. The reverential attitude which the Professor assumes when pressing the virgin sod with bended knees in search of a slope stake, or a reference point that has been yanked "hence" through the carelessness of a teamster, is worthy of the tuneful touch and loftier strain of a more competent rhymster.

Very truly, W. J. McGinty,
Secretary Ferguson Contracting Co.

Detroit, Mich., Jan. 11, 1898.

The Corrosion of Steel by Sulphur-Bearing Coal.

Sir: Will you kindly inform me through the columns of your valuable paper in regard to the corroding effect of coal upon steel? We have recently put up a steel trestle to convey coal to the mill boilers. The present idea is to dump coal between the rails and allow it to heap up as high as possible around the trestle legs, and the question is whether or not the sulphur in the coal will corrode the steel. If such a result is likely to happen, can you or your readers tell me if there is any preservative paint on the market for such a purpose? Any advice as to the best way of overcoming the difficulty (if such exists) will be greatly appreciated. Yours faithfully.

C. N. Wrightington, Mechanical Engineer.

Ludlow, Mass., Jan. 10, 1898.

(Where coal carries pyrites it is quite likely to cause corrosion of any iron or steel surface with which it is in contact, and this is especially the case if the coal is wet, or is exposed to the weather, which favors the oxidation of the sulphur. Thorough painting of the structure with a first-class paint would certainly be advisable; and we trust some of the firms who manufacture such an article will see that our correspondent is supplied with literature upon the subject.—Ed.)

Granite Telegraph Poles in Switzerland.

Sir: While traveling in Switzerland last summer I came across an engineering curiosity in the shape of a telegraph line with stone poles. This line passes along the fine military road which skirts the west side of Lake Maggiore and connects Milan with Switzerland by way of the Simplon Pass. The telegraph poles are of grey granite. They average probably 10 ins. square and 25 ft. high. I was told by a telegraph official that these poles were in use for a distance of 30 to 40 miles. I was also told that the cost of the poles in place was about ten francs, or $2 each; but I do not know how reliable this information is.

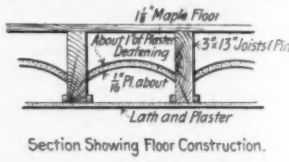
The quarries from which the poles were cut are located just above the town of Stresa. They are evidently of some importance. I noticed, when visiting them, large pieces ready for shipment to a considerable distance, one or two to the United States. My informant respecting the telegraph poles also told me that renewals were now made in wood, the principal cause of dissatisfaction with the stone poles being that they did not stand well against any transverse strain due to the pull exerted when tightening the wires. Yours very truly,

Charles H. Snow.

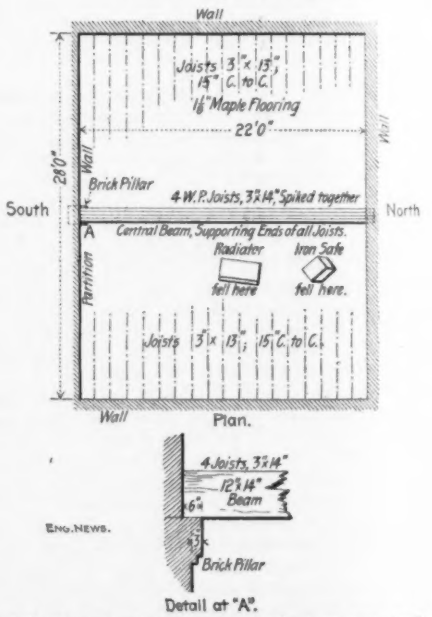
New York University, University Heights,
New York city, Jan. 3, 1898.

The Collapse of the London, Ont., City Hall Floor.

Sir: I send you herewith a small sketch showing the position of the beams, etc., in the portion of the City Hall floor in this city which collapsed on Jan. 3, killing 21 people and injuring many others. The clear floor area which collapsed was 22 × 28 ft. The joists, spaced 15 ins. c. to c., ran east and west, and were supported at the center by a beam composed of four 3 × 14-in. timbers nailed



Section Showing Floor Construction.



Sketch Showing Construction of Floor of City Hall at London, Ont., which Failed Jan. 3, 1898.

together. The room was packed with a crowd estimated at from 250 to 400 people when the accident occurred. A small platform, 8 × 12 ft., was erected at the north side of the room near an iron safe. Apparently no jumping or stamping was indulged in at the time of the break. The beam broke about 8 ft. from the south end. The timber shows some knots, but otherwise seems to be in fair condition. As the coroner's inquest is at present in session, no remarks are here made on the case, but you may get a fair idea of it from the sketch. The beam had been in place nine years. Yours truly,

W. T. Ashbridge.

London, Ont., Jan. 10, 1898.

Tests of Cast-Iron Columns by the Department of Buildings, New York City.

Sir: I have read your elaborate report of tests of cast-iron columns in your issue of Jan. 13 with great interest. Such investigations of material and calibrations of testing

machines are of the greatest value, and give to engineers more practical knowledge than numerous tests of sample specimens. It is fortunate that such machines like those at Watertown Arsenal, and at the Phoenix Iron Works, are available to the profession. However, the report of the calibration of the machines fails to state in detail how the figures in Table I. and II. were obtained.

Zero readings of the apparatus when the column was without load and initial readings are not given. It is not stated whether these readings or some of them were obtained under rising or falling pressures. It is also not stated what intervals occurred between successive applications of loads; nor is it stated whether, after every removal of the load, the column was known to be clear of the pressure blocks. A study of the figures given indicates that all facts as to how they were obtained are essential to a correct interpretation of them. It is also to be noted that only one average correction for loads applied is used, and nothing is said about different corrective factors for different loads. Trusting that you will be able to publish this additional information, I am, Yours truly,

Gus. C. Henning.

220 Broadway, New York, Jan. 14, 1898.

A proof of the above letter was sent to Mr. W. W. Ewing, the engineer in charge of the tests, and the following reply was received:

Sir: In answer to yours of the 15th inst. I beg to submit the following:

No attempt was made to record the zero readings of the apparatus when the column was without load owing to the fact that the gage used at Phoenixville to calibrate the machine, known as No. 4751, only recorded readings of 60 lbs. and upwards. This gage was subsequently used in tests of column shafts. The readings taken at Watertown were on rising pressures while those at Phoenixville were on both rising and falling pressures. It was decided to use readings of both rising and falling pressures at Phoenixville because of their similarity. The loads were applied continuously without delay, and owing to the fact that the machine was calibrated from various increments of load between 60 and 220 gage reading, the load was not entirely removed at any time during the test. The average factor for correction was taken owing to the irregularity in the various average differences of compression obtained, as shown in the tables submitted.

Mr. Ewing also calls attention to some small errors in the article on cast iron column tests in our issue of Jan. 13, as follows:

Sir: I beg to call attention to the following discrepancies in your published report from that furnished you.

1. In tables I. and II., section marked "Differences," the first lines you have added.

2. In fourth column of "Differences of Compressions" in table I., the first reading of .0141 should be .0140.

3. You state that the calibration of the machine was made with gage No. 5447, which read from zero to 220 lbs.; there was no such gage number, the calibration of the machine being made with gage No. 4751, reading from 60 lbs. upward. The small gage used for brackets, known as No. 5437, was compared at Shaw's with the "United States Standard," along with gage No. 4751.

4. In second column, p. 28, you state that you quote from my report, and print under this heading in second column, p. 29, two paragraphs giving the source of columns. These paragraphs are not contained in my report of Dec. 31, 1897.

Very truly yours, W. W. Ewing,
Special Engineer Department of Buildings.

New York city, Jan. 18, 1898.

(We should have given the gage number as 5437. According to our notes this was used to take measurements on the Phoenix column and was afterward compared with No. 4751, which was used in the column tests.

The matter referred to under 4, above, was not in Mr. Ewing's report, but was obtained from other sources. Its printing as part of the report was due to the printer's error.—Ed.)

Notes and Queries.

T. M. R. writes: "In your issue of July 29, p. 65, in connection with the failure of the Melzingah dam at Fishkill, N. Y., it is stated that damage suits have been brought against the company. I think it would be of interest to others besides the writer if you would give a summary of the court proceedings in these suits."

We are well aware that things of much interest to the profession are often made public in the trial of suits in which the testimony of expert engineers is presented; but there are several reasons why we can seldom present accounts of such proceedings in the columns of Engineering News. The main reason is that such accounts are usually of less importance and practical value to the majority of our readers than other articles which are pressing for a place in our pages. Moreover, to get at the small kernel of valuable information contained in the record of a trial one must go through so much chaff that it is a question whether it is worth the search.

GAS SALES IN THE UNITED STATES, CANADA, ENGLAND AND GERMANY.*

There have been several times in the past few years when I would have been very glad to have known the average amount of gas sold per capita throughout the country, but I did not know where to obtain accurate information on the subject. Thinking that perhaps others might need this information as well as myself, I determined to incorporate it, if possible, in this address; and to that end I have sent out within the past few weeks over 700 letters to gas companies in this country and Canada, stating my object and requesting a reply to the series of questions enclosed. Of that number about 400 have sent replies, and of these I have been able to tabulate 384.

In arranging the replies I have divided them into three classes—places under 20,000 population in the first; 20,000 to 100,000 in the second; and 100,000 and over in the third. The averages of 230 places are given in the first; 130 in the second; and 24 in the third, and are given in Table I.

TABLE I.—Sale of Gas (cu. ft.) in the United States and Canada.

	Under 20,000 population.	20,000 to 100,000 population.	Over 100,000 population.
No. of places....	230	130	24
Population. . . .	2,364,489	5,418,476	7,459,650
Av. population...	10,280	41,680	310,819
Gas sold.	2,314,168,814	7,990,568,875	16,677,871,278
No. of consumers.	102,101	323,353	621,276
Av. No. cons'mers	444	2,487	25,886
Average price ..	$1.47	$1.42	$1.10½
Total sold, meters.	2,238,303,371	7,685,203,229	15,475,959,050
Av.sold per meter.	20,523	23,586	29,478
Av. amt. received per meter. . . .	$32.77	$32.29	$32.13
Sales per cap., ft.; av. by No.places.	998	1,350	2,168
Sales per capita..	$1.58	$1.80	$2.42
Sales per cap., by total quan. sold; total pop., cu. ft.	978	1,474	2,237
Per cent. of meters to population. .	4.3%	6%	8.3%

All the averages, except those contained in line No. 13, are made up upon the basis of the number of towns in each class. I desire to call your attention to a peculiar circumstance that the average amount received per meter (line No. 10) i sbetween $32 and $33 in all three classes. This may be purely accidental, but I am inclined to think that this amount represents the average amount that can be collected per meter. The sales per capita (line No. 11) increase very rapidly with the population; and if another class had been made of cities of over 500,000, I am confident that the sales per capita would have been very much larger than in the other three; but there were so few replies received from cities of this size that it would probably have been misleading to have done so with the information in my possession. In the preparation of this matter I have naturally given it considerable thought, and it has seemed to me that the sales per capita did not express the information we were really seeking. While the gas sold per capita is interesting, and for the purposes of comparison instructive, yet that quantity is, of course, affected to a greater or less extent by the price charged; and the real thing, the keynote of this particular subject, is the amount of money received per capita—the gas sold multiplied by the price charged—and you will notice that I have given averages on this point, and they also increase with the population, although the price is lower in the larger places. I desire also to call your attention to the relation between the number of meters and the population, expressed in percentage, which also shows the higher figures for the larger places. Combining the 384 places we have a population of 15,252,615, with an amount of gas sold of 26,982,608,967 ft., and an average sale of 1,770 ft. per capita.

Through the kindness of Mr. Norton H. Humphreys, of Salisbury, England, combined with information obtained from "Field's Analysis" for 1896, I have been able to place before you some results obtained in England. These I have grouped in Table II., in three classes, by population, as in Table I.

You will notice that the averages are nearly all larger except the prices charged, and those are much lower. With many others I have always hoped that we could some day sell here the same quantity of gas that is sold in England; but I am free to confess that the more I investigate the subject the more remote becomes the possibility of such a result. In winter the lighting hours at night are longer, and the cloudy days more numerous than in this country; and in the summer, while the lighting hours are shorter, owing to the higher latitude, and the cloudy days approximate the same, yet the greater heat of this country tends to lessen the amount of gas consumed for light; and yet it is warm enough in England, combined with other causes, to induce an enormous number to use gas stoves. To these reasons add the low price at which gas is sold—which I doubt if we can ever reach—and it seems as if sufficient cause had been shown why more gas is and will be sold in that country than in this.

In this connection, I desire to call your attention to the sales of gas in London, Table II. The figures given, except as to population, are taken from "Field's Analysis," above referred to. The population, as given in "Whittaker's Almanac," is something over 4,400,000, but I am told the London Companies reach out so far beyond the city limits that that number would be incorrect. I have, therefore, assumed an arbitrary figure of 5,000,000, which, of course, is only approximately correct. I desire only to call your attention to the enormous amount of gas sold, the large consumption per meter, and the very large sales per capita. Combining columns 1, 2 and 4 of Table II., the totals are as follows:

No. of places.....	111
Total population..	8,505,600
Total sales, ft.....	36,107,393,000
Sales per capita, ft.....	4,245

In the German "Gas Journal" of July 17, 1897, there appeared an article, by Mr. Emil Merz, of Cassel, Germany. In it are elaborate tables showing the consumption of gas in a number of cities in the years 1895-96. From these tables it appears that the average sale per capita in 77 German cities is 1,830 ft.

To recapitulate: The average of gas sold per capita, from the above tables, appears to be, in—

The United States.....	1,770 ft.
Germany..	1,830 "
England....	4,245 "

*Extract from the Presidential address of Mr. Chas. H. Nettleton, of Birmingham, Conn., at the annual meeting of the American Gas Light Association.

TABLE II.—Gas Sales (Cu. Ft.) in England.

					London.
No. of places.....	74	16	*8	21	
Population.....	1,048,600	650,000	434,000	6,807,000	†5,000,000
Average population....	14,170	40,625	54,250	324,142	....
Gas sold....	3,293,836,000	2,873,120,000	2,051,748,000	29,940,437,000	30,462,170,000
Average sales....	44,511,295	179,570,000	256,468,500	1,425,735,095	....
No. of consumers.....	....	....	41,577	761,441	448,047
Average No. of consumers.....	....	....	5,197	36,259	....
Average price, cts.....	....	....	70½	59½	62.6
Total sold by meters.....	....	....	1,875,770,000	27,749,686,000	28,828,973,000
Average sold per meter.....	....	....	47,469	43,625	64,344
Average amount received per meter.....	....	....	$34.03	$26.42	$40.28
Sales per capita, ft.; av. by No. of places.	3,178	4,614	5,457	4,797	6,092
Sales per capita.....	....	....	$3.49	$2.83	$3.81
Percentage of meters to population.....	....	....	9.58%	11.19%	8.96%

*Included in 16. †Assumed.

MUNICIPAL OWNERSHIP OF THE WATER AND GAS works of Duluth, Minn., carried the day at the election held on Jan. 12. The people voted, 2,758 to 628, to buy the works of the Duluth Gas & Water Co. for $1,250,000. This was the eighth time the people had voted on the question of municipal ownership within the past few years. The old pumping plant of the water-works will be abandoned and a new one, already about ready for use, built by the city, will supply the works. The strugggle at Duluth was outlined in our issue of Dec. 16, 1897, in a letter from Mr. Henry Truelsen, Mayor of Duluth.

THE JAPANESE CRUISER "KASAGI" was launched this week at the Cramps' shipyard in Philadelphia. The "Kasagi" is a protected twin-screw cruiser with a contract speed of 22½ knots. Her dimensions are as follows: Length on water line, 374 ft. 6 ins.; beam, 28 ft. 9 ins.; depth, 30 ft. 6 ins.; draft, 17 ft. 9 ins.; displacement, 4,900 tons. She is built of mild steel and is provided with two 4-cylinder triple expansion engines, of a maximum I. HP. of about 17,000. Her armament will consist of two 8-in. breech loading rifles, ten 4.7-in. rapid fire guns, twelve 12-pdr. rapid-fire guns and six Hotchkiss rapid-fire guns. The "Kasagi" is the first foreign warship launched in this country since 1878.

THE LONDON UNIVERSAL EXHIBITION OF INVENTIONS and Manufactures will be opened on May 1, at Earl's Court, London, and $3,000,000 is reported as subscribed to insure its financial stability. Forms of application for space, plans and general information can be obtained by addressing the Secretary, London Exhibitions (Ltd.), Exhibitions Buildings, London, S. W.

THE WORLD'S PRODUCTION OF COPPER, in 1896, says "Le Genie Civil," was 387,207 metric tons, as compared with 339,699 tons in 1895. Of this total the United States furnished 212,112 tons in 1896, and 175,294 tons in 1895. Germany furnished 20,300 tons of copper in 1896, and Sweden produced about the same. The same journal places the nickel production of the world, for 1896, at 6,280 metric tons. Of this total, 2,972 tons came from New Caledonia, 1,541 tons from Canada, 90 tons from Norway and 1,677 tons from the United States. The totals in 1895 were 5,617 tons; in 1894, 6,654 tons.

INTERLOCKING PLANT AT STATE LINE CROSSING NEAR CHICAGO, ILL.

The great network of railway terminal tracks in and about the city of Chicago is probably the most extensive and complicated system of terminal tracks at any railway center in the world. With the growth of both the city and the railway systems, with the consequent increase in both street and railway traffic, two very important engineering improvements have become necessary on this great network of lines. They are, first, the elevation of the tracks through the city; second, the protection of all junctions and grade crossings by means of signal and interlocking plants. The first of these has been undertaken mainly for the safety and convenience of street traffic, although it is of great benefit to the railway traffic as well. The second is now a well recognized necessity for the safe and convenient handling of the railway traffic. Several of the important works of both classes have been described and illustrated in our columns, and in the present article we deal with the datest and largest of the interlocking plants, which is also one of the largest in the country.

This plant is at the State Line crossing, just south of the Chicago city limits, and near Hammond, Ind., where several railways cross and connect with each other. During the past year, the Chicago, Hammond & Western R. R., which is one of the important terminal roads of Chicago, built an extension of its line which intersected this crossing, and under the laws of the State of Illinois it developed upon this road to put in an interlocking plant for the protection of the entire crossing as a whole. The plan, Fig. 1, will give an idea of the complicated system of crossings and junctions to be protected. The tracks are used by eleven railway companies, eight of which own tracks, while three use the tracks as tenants. The eight owning companies are as follows: (1) Chicago, Hammond & Western R. R.; (2) Chicago & Western Indiana R. R.; (3) Chicago Terminal Transfer R. R.; (4) Chicago & Erie R. R.; (5) New York, Chicago & St. Louis R. R.; (6) Michigan Central R. R.; (7) Chicago, Indianapolis & Louisville Ry.; (8) Chicago & Indiana State Line R. R. (a terminal line of the Pennsylvania Lines West of Pittsburg). The three tenant companies are as follows: (9) Wabash R. R.; (10) Elgin, Joliet & Eastern R. R.; (11) Chicago, Lake Shore & Eastern R. R.

Each company arranged its own tracks, and the interlocking was planned under the direction of Mr. J. B. Cox, Signal Engineer of the Chicago, Hammond & Western R R., after conference with the representatives of the other companies interested. The contract for the execution of the work was awarded to the National Switch & Signal Co., of Easton, Pa., and the details of the plan and the interlocking plant were worked out by Mr. Charles Hansel, M. Am. Soc. C. E., Vice-President and General Manager, and Mr. Henry M. Sperry, the Signal Engineer and Western agent of that company. The construction was done under the direct supervision of Mr. Cox and Mr. Sperry.

The signal tower is of unusual size, being 100 ft. 8 ins. long and 16 ft. 0½ in. wide. The operating floor is 15 ft. above the level of the rail heads. The walls are of pressed brick, laid in cement, and the roof is of Bangor slate. The second story or operating floor, has windows on all sides, affording an unobstructed view of the entire crossing. It is heated by two Beckwith hot-air furnaces. The locking frame is below the operating floor, and is of the vertical type, occupying no floor space. It is very compactly arranged, though it includes 2,500 ft. of locking bars and 900 locking dogs. A special feature of this frame is the substantial manner in which it is supported. A steel plate girder, 20 ins. deep, is carried by five steel columns on concrete foundations, and on the girder stand cast-iron columns supporting the lever frame. This construction, shown in the view of the locking frame, Fig. 2, guards against any distortion which might occur with such a length of locking frame if carried on wooden supports.

The levers are all arranged in one row, as shown by the interior view, Fig. 3, and the telegraph instruments, etc., are placed behind them. A novel feature in the arrangement of the levers is that instead of all the switch levers, all the signal levers and all the lock levers, etc., being grouped together, as in ordinary practice, the levers are arranged in three principal groups, for the three principal sets of train movements. This greatly facilitates the work of the signalmen, as for any one train movement, the switch, signal and lock levers are all close together. The lever frame or machine frame is about 94 ft. long, with spaces for 224 levers, of which 157 are now in place. The interlocking plant at the 75th St. crossing has 132 levers (Eng. News, Sept. 20, 1894), and that at Dolton, Ill., built in 1897, has 172 levers. The distribution of the levers at the State Line plant is as follows:

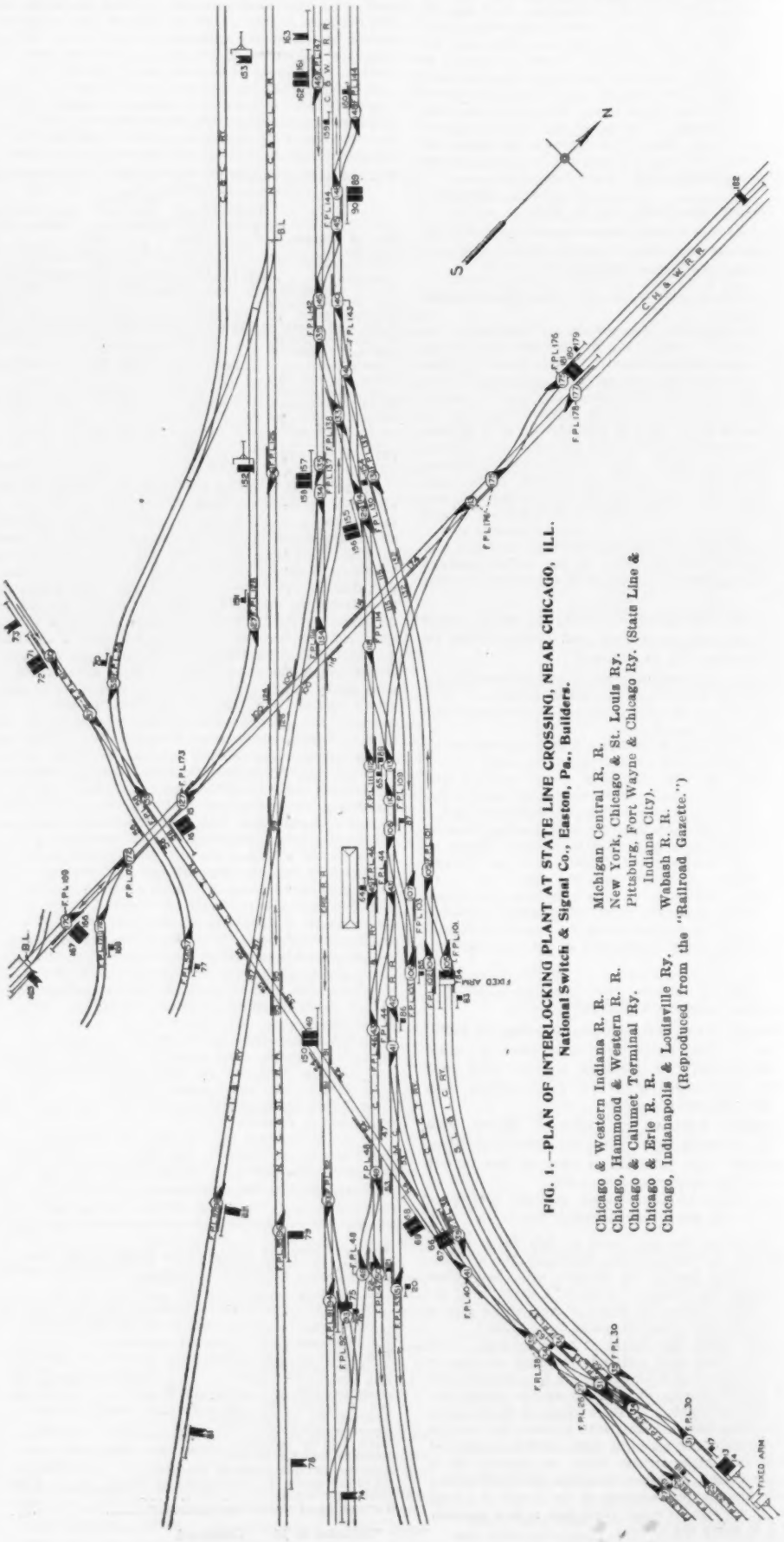


FIG. 1.—PLAN OF INTERLOCKING PLANT AT STATE LINE CROSSING, NEAR CHICAGO, ILL.
National Switch & Signal Co., Easton, Pa., Builders.

Chicago & Western Indiana R. R.	Michigan Central R. R.
Chicago, Hammond & Western R. R.	New York, Chicago & St. Louis Ry.
Chicago & Calumet Terminal Ry.	Pittsburg, Fort Wayne & Chicago Ry. (State Line & Indiana City).
Chicago & Erie R. R.	Wabash R. R.
Chicago, Indianapolis & Louisville Ry.	

(Reproduced from the "Railroad Gazette.")

Levers for 68 switches and 1 movable point frog	45
Levers for 70 facing-point locks and 20 crossing or detector bars	43
Levers for 19 crossing bars	6
Levers for 63 signals	63
Working levers	157
Blank spaces	67
Total number of levers (when completed)	224

The switches and locks are operated by levers of 1-in. pipe laid on double anti-friction carriers. These are placed 7 ft. apart c. to c. of rollers. Each signal is operated by two lines of No. 9 wire, carried on pulleys 21 ft. apart c. to c. The connections for operating the plant comprise 62,000 ft. of pipe line (about 47 tons) and 109,000 ft. of wire. The most distant signal is 2,492 ft. from the tower, and the most distant switch is 1,242 ft. from the tower. At three places where the

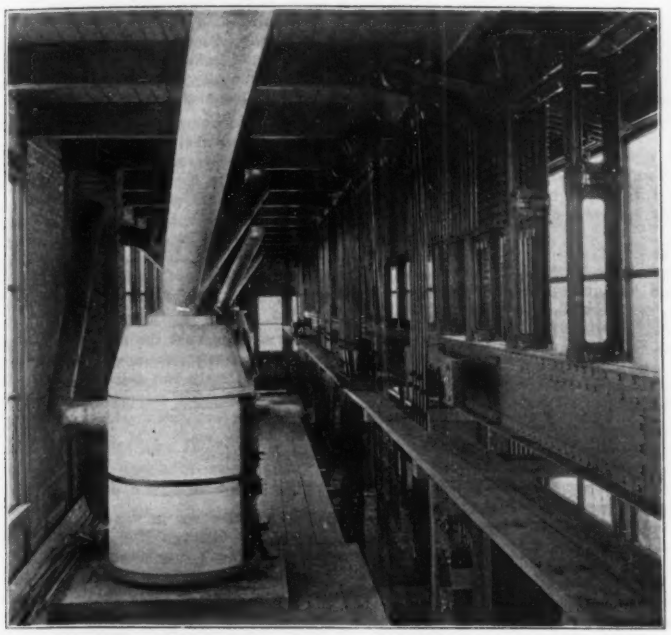


FIG. 2.—INTERIOR VIEW OF SIGNAL TOWER, SHOWING LOCKING FRAME.

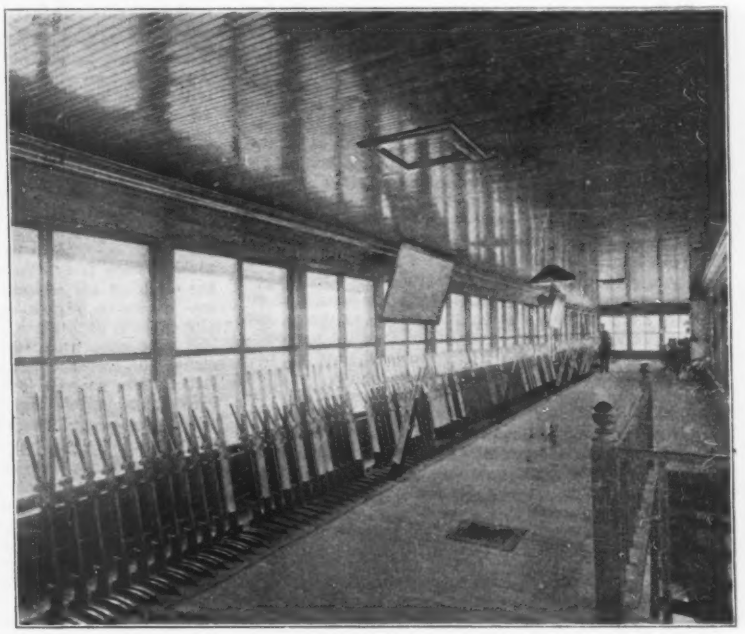


FIG. 3.—INTERIOR VIEW OF OPERATING ROOM OF TOWER.

connections pass under the tracks, the rails are supported by special forms of steel ties resting on longitudinal timbers. The foundations for the interlocking are of the improved design for timber foundations, shown in our issue of Jan. 13, the bell-crank and compensator foundations being set in concrete.

In one important respect the conferences between the representatives of the railway companies did not result as satisfactorily as might have been wished, and that is in the matter of uniformity. Some of the railways insisted that certain special arrangements and equipment employed on their lines should be fitted for the tracks to be used by them, and the result is that the standards of three railway companies had to be followed in putting up the work. The Chicago & Western Indiana R. R. uses the ordinary form of semaphore, while the State Line & Indiana City R. R. uses a design that is standard on the Pennsylvania Lines, in which the arm of the semaphore drops to a vertical position, parallel with the post. The semaphore arms for the tracks of these two roads have the running face painted yellow, with a black stripe, while all the other semaphores have the running face painted red or green (for home and distant signals respectively), with a white stripe. There are also different forms of fittings required for switch connections, plunger locks and other details. This involves a needless and unfortunate complication, to which we have briefly referred in our editorial columns. The responsibility for this, of course, rests entirely with the railways and not with the signal company, as the company made strong efforts to bring about the adoption of some uniform system throughout.

The traffic includes nearly 200 trains per 24 hours, with 50 train orders and 50 telegraph messages in addition. Mr. J. M. Warner, Superintendent of the Chicago & Western Indiana R. R., informs us that the records for Dec. 3, 4 and 5, show a maximum of 184 trains in 24 hours, while the busiest hour during that period was from 10 to 11 a. m., on Dec. 4, during which time 26 trains used the interlocking plant. All this work is attended to by six lever men, working two at a time on shifts 8 hours long. There is also one lamp man and one repair man in charge of the maintenance of the plant. The following are the instructions governing the operation and maintenance of the interlocking plant, as furnished us by Mr. Warner:

1.—Levermen will report to and receive instructions from the Signal Engineer concerning the operation and maintenance of the plant, and will receive instructions from the Superintendent or Pilots as to special movements of trains.

2.—Signals must be kept at danger, except when in use for train movements, and must be returned to danger position as soon as train has passed.

3.—Clear signal must not be given until it is known that the route governed by it is clear.

4.—Do not attempt to move a switch or detector bar when a train covers it or is closely approaching it.

5.—When interlocking is not in use, all levers (excepting those for locks) should be kept in normal position.

6.—Should it be necessary to change a route, after clear signal has been displayed to an approaching train, the signal may be returned to danger, but the switches must not be changed nor signal given for a conflicting route until the first train signalled has come to a full stop. Signal must not be given for a route when cars or engines are standing between the derails of a conflicting route.

7.—In case of accident the Superintendent, Signal Engineer and Repairman must be notified at once, and no trains allowed to pass until parts liable to damage have been examined and found in safe condition.

8.—A failure of any part of apparatus to work properly must be reported at once to Signal Engineer and Repairman.

9.—No part of the signal or track appliances, nor any part of the machine, should be disconnected except in case of accident.

10.—When, from any cause, signal is out of order and cannot be set to clear, leverman, after ascertaining that the route is safe, must personally notify the engineman that signal cannot be given but route is all right for him to proceed.

11.—When, from any cause, signals, locks or switches are disconnected from the machine, all movements must be made under direction of leverman.

12.—Levers should be handled by a steady movement.

13.—During freezing weather levers must be handled frequently to keep connections free.

14.—Allow no one to handle levers except duly authorized employees of signal department.

15.—Levers and all machinery above working floor must be kept bright and clean.

16.—Keep all lights in tower so they cannot be seen from approaching trains.

17.—Allow no one in tower except employees in the discharge of their duties.

18.—Report to Signal Engineer all enginemen running their trains past danger signal or using sand on switches or detector bars.

19.—Bell signals for communication with other points are to be used in accordance with established codes. All bell signals must be plainly given and promptly answered.

20.—Report daily to Signal Engineer, on blank prepared for the purpose, all delay to trains, also condition of plant.

21.—Lampmen will report to and receive instructions from Signal Engineer.

22.—Their regular duties are to inspect all signals, switches, derails, detector bars, locks and other moving parts daily, and report promptly to leverman any defects discovered; keep the switch points free from obstructions; clean and oil the interlocking machinery and moving parts so they shall present a neat appearance and work smoothly at all times; take care of the lamps and assist levermen in scrubbing floors and cleaning windows.

23.—Lamps must be lighted and put up before sunset and remain in place until after sunrise, proper allowance being made in foggy or stormy weather, to insure their being in position during such hours as may be necessary to display night signals; lamps should be cleaned and filled as soon as taken down.

24.—Keep fire buckets filled and ready for use in case of fire, and use them for no other purpose.

25.—Make monthly report to Signal Engineer of oil and other supplies used.

J. M. Warner, Superintendent.
Geo. Espy, Signal Engineer.

THE RELATIONS BETWEEN THE CUSTOMER, CONSULTING ENGINEER AND ELECTRICAL MANUFACTURER.*

By S. Dana Greene, M. Am. Inst. Elec. E.†

The manufacturers of apparatus and the manufacturers of current are dependent upon each other to a large extent, and their relations should be close and friendly. The consulting engineer, as in other engineering trades, is a necessary and proper connecting link between the two, and I can say frankly that I believe he has a proper and permanent field of usefulness. Broadly speaking, his function is to see that his client who buys apparatus and installs it, selects first that system best suited to his particular local conditions, and then, in purchasing, secures the best (not necessarily the most) for his money. It is equally the duty of the consulting engineer to learn what the manufacturer can reasonably be called upon to make, to consult with him freely and to obtain the benefit of his experience; to give him credit for work well done, and to insist that bad work shall be promptly corrected.

Many consulting engineers, especially those who have recently commenced practice, seem to think that it is improper for them to consult with the manufacturer, or to examine his plant, or to ask him for information or advice. Their idea seems to be that by so doing, they may be accused of partiality or undue bias, or with lack of proper care for the interests of the purchaser; or they may feel that it is derogatory to their own dignity as independent engineers. The inevitable result is that specifications often contain provisions which are a source of annoyance and expense to the manufacturer and purchaser alike, and which have no compensating advantages, from either the engineering or commercial standpoint. In fact, some of these provisions are impossible or impracticable of fulfillment; and in such cases the honest manufacturer who wishes to meet the specifications and guarantees required, finds himself forced to ask the engineer or the purchaser (sometimes both) to modify them. This is a proceeding which is always difficult and delicate to undertake, and often results in friction and trouble for all concerned.

I am satisfied that if every consulting engineer would take advantage of opportunities as they occur, to visit manufacturing establishments, see the work there in progress and confer with the engineers, he would find himself well repaid for the visit, and his own work and practice benefited thereby. I am equally satisfied that no reputable manufacturing establishment would refuse admittance, but on the contrary would welcome such visits

*From a paper read before the New York Electrical Society, at the College of the City of New York, Jan. 12, 1898.

†Asst. General Manager General Electric Co., Schenectady, N. Y.

as beneficial to both parties. The day of mysterious methods of manufacture, carried on behind closed doors, is passed in the electrical business, and I appeal with confidence for an endorsement of the opinions just expressed, to those consulting engineers who have already tried the plan suggested. I have said that I thought the engineer would find himself repaid by such visits. I think, also, that he will find himself in a better position to advise his client intelligently. A purchaser usually knows little or nothing of the relative technical merits of apparatus, and his final decision is governed largely by price and by paper statements and guarantees, which may mean much or little. The consulting engineer who has seen the apparatus in process of manufacture can advise not only as to whether the various bids comply with the specifications, but also what make or makes of apparatus are, from their design, construction and factory inspection and test, most likely to give the least trouble and expense in continuous service.

Advantage of Specifying Standard Apparatus.

Some engineers seem to measure their value to the purchaser by the length of their specifications, and some of these formidable documents strike terror to the heart of a busy man confronted by a desk full of mail. The specifications not only specify what the conditions of service are, what apparatus is required and what tests shall be applied to it for acceptance, all of which are quite proper; but also how it shall be built, which is another matter. The electrical manufacturers of this country following the admirable precedent which has given American manufactured products (particularly machinery) a world wide reputation, have endeavored to establish standard lines of apparatus, whenever the permanency of type and the size of the demand warrant it. This practice not only tends to reduce cost (and with it price), but also enables the purchaser to secure quickly and at a minimum of expense, duplicate parts which are really duplicates and which can be fitted without the aid of a skilled mechanic. It is the American system of standard lines of machinery and interchangeability of parts, which has stood the test of time and which holds its own against all competitors. This system, however, is possible only where the same article is manufactured in quantity, since the expense of designs, drawings and patterns, special tools, jigs, dies, etc., is prohibitive unless spread over a large production. On the other hand, if special apparatus is required, it means a relatively large expense for these items which cannot be charged to a standard product, and which thus constitute a handicap both to the manufacturer and the purchaser. A machine is "standardized" only after long experience, both in manufacture and service, and other manufacturers (the builders of engines, trucks, etc.) as well as the users, are invariably consulted before such standardization. It would appear to be to the interest of both seller and buyer to use such standard machines, wherever and whenever possible; and yet it seems to be a fact that the demand for special machines is increasing, rather than decreasing, as apparatus becomes more generally standardized.

Tests and Guarantees Prescribed by Specifications.

Omitting from consideration matters which, as already stated, belong properly to the designer and builder, such as current densities in the windings or in brushes, methods of insulation, kinds of material, etc., etc., the tests necessary to determine a machines quality (and hence its value to the purchaser) are few in number and can be enumerated under the headings of efficiency, heating, regulation, sparking and insulation. If the requirements under these five headings were formulated under some general rules, and if the methods of tests to determine results were uniform, the work of the consulting engineer and the manufacturer would be vastly lessened. Such, unfortunately, is not the case, and specifications on these points vary widely both as to requirements and as to the method of test. It seems practically impossible for the various manufacturers and consulting engineers to standardize these requirements and tests by any concerted action, and the only other solution of the difficulty is for some scientific non-partisan organization to undertake the work. The American Institute of Electrical Engineers is just such a body, and it would render a great service to the entire electrical business if it would consider the matter. Without attempting in any way to suggest what action it should take, it seems proper to call attention to some of the points which most frequently give rise to misunderstanding and disputes.

1. Efficiency.—The proper distinction between electrical and commercial efficiency is not made. The latter is what interests the purchaser and it should always be specified. A clear statement of what losses must be included to determine it, and also a general statement of what constitute reasonable and proper commercial efficiencies in well designed machines would be of great service. Such a statement should show the necessary difference between carbon and copper brushes, and between the voltages most commonly used in direct current work, viz.: 125, 250 and 500 volts, as well as between machines of various sizes. The formulation of such information on alternators is more difficult, but all manufacturers have certain standard lines of these machines and it is quite possible to make some intelligent general rules.

Electrical manufacturers are sometimes required to guarantee the combined efficiency of generator and engine (or other prime mover). This is clearly unfair and shifts the direct responsibility of guarantee from the maker of the prime mover, where it probably belongs.

2. Heating.—For all ordinary conditions of service, the safe heating limits for continuous full load operation can be determined with a fair degree of accuracy. The commutator heats more than any other part of the machine, particularly with carbon brushes, a fact which is often ignored. Sometimes the heating is measured by thermometer, sometimes by increase in resistance. There should be one uniform method followed. Overload guarantees (ranging from 25% to 100%) are sometimes required for a period within which the ultimate temperature of the machine is reached, and the necessary capacity of the machine is thus increased as certainly as though a larger machine were specified. It would seem that the time duration of overload tests should bear some relation to service conditions. If the service requires a 50% overload for eight hours or more, a larger machine is evidently necessary.

3. Regulation.—Specifications frequently call for a straight line compounding curve, a condition which is practically impossible until we discover a magnetic material which has a straight line saturation curve. Another common requirement in the case of lighting generators, is that a drop of, say, 2% in speed shall not affect the electromotive force more than 2 volts, which is also an impossible condition, even with a separately excited generator. A reasonable margin in either case, having due regard to the service for which the generator is intended, should always be allowed.

4. Sparking.—Modern design, and the use of carbon brushes, have greatly reduced the trouble from sparking, but machines are sometimes called upon to stand excessive overloads without sparking, which can be accomplished only by using a larger machine or by a distortion of design, which is bad practice. Any good machine, with carbon brushes, should be able to stand a variation from no load to full load without movement of brushes and without noticeable sparking; it should also stand a reasonable overload, say, 25%, without injurious sparking.

5. Insulation.—This is a cause of frequent trouble and annoyance. The common practice is to specify an insulation resistance of so many megohms, regardless of the size of the machine and the voltage and conditions of service. Considering the fact that this resistance varies inversely as the area of surface to be insulated, and considering the enormous variation in size, shape, voltage and service requirements of different machines, it is evident that such a test is impracticable and means little or nothing. Insulation resistance is largely a question of dryness, and if an armature be baked for a sufficient length of time, almost any resistance within reason can be obtained. I have known a large 400 K-W. lighting armature to measure a megohm resistance, as required by specifications, after several days' baking (which, by the way, permanently injures the structural strength of the insulating material) and yet it showed practically no resistance when it reached its destination, because it had been in the rain and dampness for a week or more, and the large surface naturally afforded an excellent lodging place for moisture. A day's run in a weak field, with the armature short circuited, quickly brought the insulation up again.

The only proper way to insure good insulation, with reference both to the material used and the method of construction employed, is by a high potential test applied when the machine is reasonably dry. This test should be intelligently gaged by the voltage of the machine and the service required. Thus a high potential test of 1,000 volts is ample to detect any insulation weakness in a 125-volt lightning generator, while a 5,000-volt test is ample for a 1,000-volt alternator, allowing proper factor of safety in each case. Recent careful investigations have developed the fact that the only correct way in which to determine the proper high potential test for any given machine is to consider jointly the time duration of test, the current frequency and the voltage of machine. As the latter rises, the margin between it and the test voltage necessarily decreases on account of the liability to permanent injury of the insulation when subjected to excessive voltages. Because 5,000 volts is found to be a proper test voltage for a 1,000-volt machine, it by no means follows that 50,000 volts is proper for a 10,000-volt machine, or that the apparent factor of safety should be the same as the voltage rises. There should be a careful formulation of proper high potential tests for different classes of apparatus, based upon scientific investigation and tests, and it is believed that it would not be a matter of any great difficulty to formulate such a schedule.

We come finally to the commercial requirements which have gradually found their way into specifications, and which are sometimes onerous and unfair. Perhaps the most important of these is the question of shipments. It is not uncommon for shipment to be specified by a certain date, under a forfeiture of so many dollars a day for each day's delay thereafter, and the award of the contract is often largely affected by such promises. The manufacturer starts the work in his shops, and if the time is short he is apt to work overtime. About the time the apparatus is ready for shipment, and without any previous warning, word comes to withhold shipment because the purchaser is not ready to receive it. There were recently 15 carloads of apparatus lying in the yards of one of our manufacturing establishments, besides a number of large machines stored in the shipping and testing departments, which had been made on time contracts and held at the last moment by request of the customer. It is difficult for one not in this end of the business to realize the resulting demoralization throughout the shops, and it is a condition which could easily be remedied by the exercise of more foresight on the part of the purchaser and his engineer. In all cases where a penalty for delay in shipment is imposed, it is fair and reasonable to ask that a similar bonus should be awarded if shipment is made in advance of promised date, or if the purchaser is unable, through no fault of the manufacturer, to receive the apparatus on that date. It is sometimes required that the consulting engineer shall have full access to the shops at all times while the apparatus is in production. Such permission is impracticable if proper shop administration and discipline are maintained, and these visits should be made at certain specified stages of the work. It is, of course, always proper for an engineer to be present when the apparatus is finally tested.

A clause is commonly found in specifications providing that the consulting engineer shall be sole judge of the true intent and meaning of the specifications; and in case of any dispute thereunder his decision shall be final and binding. It is true that this clause is common in architects' and builders' contracts, but it is doubtful whether it could be enforced at law, in case of a dispute as to facts, and it certainly seems fair that in case of such a dispute, where the two parties honestly disagree, provision should be made for a third, disinterested party to act as arbiter.

In conclusion, let us hope that the customer, the consulting engineer and the manufacturer will, in the future, consult each other more freely and frankly, and that all of them will unite in indorsing any intelligent attempt to standardize such tests and technical requirements of electrical apparatus as are matters of common usage in our daily business intercourse.

Discussion.

Mr. Max Osterberg, referring to the requirement by consulting engineers of a combined efficiency for both engine and generator, said that a considerable amount of the construction work and installing of machinery is done by general contractors, the manufacturer being a sub-contractor. Mr. Gano S. Dunn advocated a meeting of manufacturers and consulting engineers to formulate standard specifications and tests. He said that salesmen were, to a large extent, responsible for the great amount of special work required. Consulting engineers are beseiged by salesmen, representing all sorts of firms, who readily promise to meet any or all conditions that can be suggested. He knew of one engineer who specified efficiencies impossible to attain, and defended himself with the plea that in this way he would make the manufacturer do his best. Mr. Dunn considered that details should be left almost entirely to the manufacturer and the apparatus refused or accepted upon the final results which it gives under standard tests.

Dr. Chas. F. Emery said that if the manufacturers would get together and formulate some code or standard sets of specifications they would probably be generally accepted by engineers. Some manufacturers already have standards which might, with slight modifications, be made generally applicable. Some of the difficulties which would be met in any attempt to standardize were experienced at the World's Fair. In the overload tests, for example, one manufacturer voluntarily overloaded his machines fully 25%, while another refused to overload at all. In defense of the requirement of combined engine and dynamo efficiency, Dr. Emery stated that a given variation of load caused a much greater variation in engine efficiency than in dynamo.

A motion was adopted that the Society endorse the project to have standard specifications and invite the American Institute of Electrical Engineers to take up the subject.

Mr. H. B. Coho said he had frequently to refuse work where special apparatus was required, but he favored consulting engineers because, when work was accepted by the engineer in charge, money was always promptly forthcoming. He thought that consulting engineers were to be thanked for many of the improvements. Neither did he, as a manufacturer, object to long specifications.

Dr. Francis B. Crocker stated that the policy of the Institute of Electrical Engineers was to act with much care in taking up questions of purely commercial nature. However, the formation of a standard code or set of specifications is at present under consideration.

In closing the discussion, Mr. Greene admitted the need of outside influence to overcome the inertia of a large manufacturing establishment, and said that consulting engineers were not only useful but essential to the welfare of both manufacturer and purchaser.

A NEW FORMULA FOR LEATHER BELTING.

In a paper read before Section D, of the American Association for Advancement of Science, at the Detroit meeting, Prof. J. J. Flather, of Purdue University, Lafayette, Ind., discussed a formula for obtaining the width of leather belting when the average conditions under which it is to work are known.

The ordinary formula, $b = \frac{C \times HP.}{V}$, in which C has values varying from 500 to 1,100 for single belting, is not generally applicable to varying conditions and the author presents a formula which allows the width of belt to vary with a number of factors, all of which are either known or can be readily determined from the given conditions.

The loss due to centrifugal effect at high speed and the influence of the arc of contact are recognized in many accepted rules for belting, and in addition to these Prof. Flather takes into account the diameter of pulley when the latter is small, and also the character of joint—whether laced or cemented splice.

The formula presented is

$$b = \frac{CC'C''k_o HP.}{V}$$

in which the values CC' C'' and k_o are given in the tables accompanying the paper.*

In determining the value of C for single belting, the thickness was assumed at 0.20 in.; its heaviness 0.41 lb. per sq. in., section 1 ft. long; the allowable working stress 350 lbs. for cemented joints (per sq. in. section) and three-fourths of this, or 265 lbs., for laced joints. The coefficient of friction was taken equal to 0.27 for small slip and ordinary good belting. In this determination the pulleys were assumed of approximately the same diameter, which was not less than 50 times the thickness of the belt. C, under these conditions, was found to equal 800 for cement and 1,050 for laced joints.

C' varies from 1.4 for double belts running over an 8-in. pulley to 1.10 for same when used with a 20-in. pulley.

C'' varies from 1.33 with a least arc of contact of only 120° to 0.75 for similar arc of 240°. k_o is not to be considered for speeds less than 2,000 ft. per minute. For 2,500 ft., $k_o = 1.06$ for cemented joint, and for a speed of 5,000 ft., $k_o = 1.34$.

Table I.

Values of $C = \left(\frac{V\ b}{HP.}\right)$

	Cement joint.	Lace joint.
Single belt	800	1,050
Double belt	800 / 2	1,050 / 2
Triple belt	800 / 3	1,050 / 3

In the above V = velocity of belt in feet per minute, and b = breadth of belt in inches.

Table II.

Values of C' = multipliers when double or triple belts are used with small pulleys.

For double belts when diam. of pulley =	Or triple belts when diam. of pulley =	Value of coefficient, C'
8 ins.	18 ins.	1 + 0.7 = 1.40
12 "	26 "	1 + 0.8 = 1.25
20 "	42 "	1 + 0.9 = 1.10

Table III.

Values of C'' for different arcs of contact.

Value of angle embraced by belt.—In degrees.	In circ. measure.	Value of coefficient C''
120	2.08	1.33
130	2.26	1.27
140	2.45	1.21
150	2.62	1.15
160	2.79	1.10
170	2.96	1.05
180	3.14	1 00
190	3.32	.95
200	3.49	.91
210	3.66	.87
220	3.84	.83
230	4.02	.79
240	4.18	.75

Table IV.

Values of coefficient k_o = multiplier when centrifugal effect is considered.

Velocity in ft. per minute (V).	Value of k_o for— Cemented belt.	Laced belt.
2,500	1.06	1.10
3,000	1.10	1.14
3,500	1.14	1.20
4,000	1.19	1.27
4,500	1.26	1.37
5,000	1.34	1.50
5,500	1.44	1.65

*See "Western Electrician," June 12, 1897, for mathematical investigation of the formula.

WEATHER TABLE FOR DECEMBER, 1897. (Furnished to Engineering News by the Department of Agriculture.

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—rain or melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	22.4	58	−10	68	8.7	35	NW	3 26	1 52	12
	Portland, Me.	28.0	55	5	50	7.0	30	N	4.22	1.50	13
	New York City	35.8	60	9	51	12.3	48	NW	4.83	2.15	12
	Pittsburg, Pa.	36.9	65	9	56	7.7	28	W	3.44	1.17	14
	Chicago, Ill.	29.0	57	− 2	59	18 2	56	SW	1.62	0.56	12
	Omaha, Neb.	21.8	47	−12	59	7.6	25	NW	1.79	0.51	12
	St. Paul, Minn.	15.4	45	−12	57	7.6	26	NW	0.20	0 11	4
	Duluth, Minn.	14.2	40	−15	55	9.0	46	NW	0.85	0.28	8
	Bismarck, N. Dak.	14.0	52	−23	75	7.5	40	NW	0.30	0.12	7
	Average.	23.7	53	− 6	59	9,5	37		2 28	0.88	10
Southern Cities.	Washington, D. C.	38.1	68	14	54	6.8	34	NW	3.35	1.15	12
	Louisville, Ky.	37 9	70	13	57	9.3	28	SW	3.05	0.78	12
	St Louis, Mo.	32.8	64	10	54	9.8	28	SW	3.43	1.03	11
	Savannah, Ga.	53.7	77	36	41	7.3	27	NW	2.26	1.45	8
	Kansas City, Mo.	28.0	68	3	65	8.6	31	NW	1.36	0 61	9
	Jacksonville, Fla.	58.5	80	36	44	6.0	25	SW	4.84	2.89	11
	Chattanooga, Tenn.	43.8	66	24	42	7.4	40	W	6.91	1.81	17
	New Orleans, La.	57.0	77	34	43	9.4	35	NW	4 0 0	1.24	9
	Memphis, Tenn.	41.4	70	22	48	10.0	48	NW	5.80	1.28	14
	Palestine, Tex.	47.4	74	18	56	7.1	26	NW	6.81	1.46	13
	Average.	43.9	71	21	50	8.2	32		4.18	1.37	12
Western Cities.	Helena, Mont.	23.8	55	−16	71	7.8	45	SW	0.59	0.24	10
	Port Angeles, Wash.	41.0	52	30	22	4.5	36	W	9.85	2.63	22
	San Francisco, Cal.	50.7	63	39	24	6.7	34	SW	1.22	1.02	5
	Salt Lake City, Utah.	27.4	52	2	50	4.6	30	S	1.47	0.68	9
	Santa Fe, N. Mex.	29.0	53	8	45	7.3	36	NW	0.64	0.22	6
	Denver, Colo.	28.3	62	−8	70	8.9	53	W	0.63	0.31	8
	Yuma, Ariz	52.9	75	28	47	—	52	NW	0.04	0.04	1
	Average.	36 1	59	12	47	6.6	41		2.06	0.73	9

STONE ARCHES OF LARGE SPAN WITH ARTICULATED JOINTS OF LEAD.

In 1885 to 1891, says M. Humbert in the "Annales des Ponts et Chaussees," for the 3d quarter of 1897, M. Liebbrand, Director of Roads and Navigable Ways, in Wurtemberg, built a number of masonry highway arched bridges, which presented some interesting peculiarities of construction. The first masonry arched bridge of the Wurtemburg series was built in 1882 upon French methods. It had a span of 108.24 ft., with a circular arch 5.25 ft. thick at the spring and 3.28 ft. thick at the crown. Notwithstanding the precaution taken, and the use of Portland cement, the voussoirs near the springing line began to show slight cracks, though the centers had not been struck until 42 days after the setting of the key.

This experience led the engineer to attempt the employment of articulated joints, at the key and at the points of rupture, so arranged as to permit the arch to freely take its own bearing during construction and upon striking the centers. These joints were to be made by the interposition of sheets of lead, about 20 mm., or 0.79-in. thick, and occupying only the middle third of the joint area; the other two-thirds remaining empty. His theory was that if this lead were submitted to a pressure surpassing the resistance of the metal, it would yield and spread, without losing cohesion, and the surface would increase until the unit pressure was reduced to a figure that could be supported.

Experiments were then made upon the resistance of lead to compression, with the following results: Cubes of cast lead, 8 cm., or 3.15 ins. on a side, withstood, without sensibly flattening, a pressure of 50 atmospheres per sq. centimeter, or about 4,741 lbs. per sq. in., continued through 26 hours; and the cube commenced to yield slowly under a pressure of 72 atmospheres. Plates of rolled lead, about 4 ins. square and 0.98-in. thick, gave a mean resistance of 67 atmospheres, or about 6,350 lbs. per sq. in., and commenced to yield under a pressure of 75 atmospheres. The addition of a slight proportion, or about 5% of antimony largely increased the resistance of the lead; plates of this mixture, 3 ins. square and 0.98 ins. thick, resisted a pressure of 400 atmospheres, and only commenced to yield under 500. This alloy provided the means for securing leaden joints sufficiently resisting to meet any pressure likely to come upon them.

In the first arches constructed upon this system the width of the lead sheet was one-third that of the arch at any given joint of articulation. This width was equivalent to a uniformly distributed pressure of 60 atmospheres per sq. centimeter, or 5,710 lbs. per sq. in., of lead; and under the most unfavorable curve of pressure, to a maximum pressure, on one side only, of 120 atmospheres. Experience has proven that, upon the most heavily loaded parts of the lead joints, no traces of deformation appear. This leads to the conclusion that either during the execution of the work the lead behaves in such a manner as to spread the pressure over its whole surface; or, that the resistance of lead in sheets of a large size is greater than that of the pieces submitted to test, and that this resistance reaches at least 120 atmospheres. The first supposition is the more probable; and in the planning of the two great bridges over the Valley of the Murg, recently constructed, a uniformly distributed pressure over the leaden plates of almost 120 atmospheres was figured upon.

The author gives in tabular form the dimensions of seven arched masonry bridges thus built, between 1885 and 1891. The spans range from 51.2 to 108 ft. They all show a lowering of the crown when the centers were removed, ranging from 18 mm. for the 51.2 ft. span to 163 mm. for the 108 ft. span. Six of these bridges were built of stone; and at the points of rupture, plates of lead, 0.86-in. thick and of a width varying with the span, were put between the voussoirs for the whole width of the bridge. At the summit of the arch two leaden joints were used, equidistant from the axis.

The employment of these leaden joints, says the author, was advantageous in passing the line of pressure through the three points of articulation; as the thickness of the arch was reduced to the resistance of the materials employed. The general result was economical.

The seventh arch, of 59 ft. span, was for a railway bridge at Ehingen, and was built in beton. The body of the arch was made of beton, of 1 cement, 2 sand and 6 gravel, and in this beton rough stone blocks were imbedded. At the points of rupture and at the key, two rows of stone voussoirs were introduced and between these were placed sheets of lead 0.86-in. thick. The plates of lead, which in the first arches had a width of one-third of the joint, in more recent work have been reduced in width to one-sixth of the joint. At the Forbach arch, the pressure upon a plate of this latter width has almost equalled 102 atmospheres, without any apparent injurious effect upon the lead or upon the voussoirs.

THE POPULATION OF JAPAN, as determined by the census of Dec. 31, 1896, was 42,708,264 for the Empire, Formosa excepted. The male and female population is almost exactly evenly divided, and there are 8,004,819 families. The noble class numbered 4,375.

THE ENGINEERING COLLEGE of Tokio, Japan, is described in "The Engineer," of Dec. 3. The Imperial University of Tokio, of which this college is a part, was practically founded in 1873, but only occupied its present

site and assumed some importance in 1884. The university now contains nearly 2,000 students, under the general direction of Prof. Arata Hamao. The subjects taught are law, medicine, literature, science and agriculture. The Engineering College includes 345 students, officered by a director, honorary secretary, 15 professors, 9 assistant professors and a number of lecturers on special subjects. There are nine separate courses of instruction for engineers, each extending over three years. These are: civil, mechanical and electrical engineering, naval architecture, technology of arms, architecture, applied chemistry, technology of explosives, mining and metallurgy. The engineering museum contains over 25,000 exhibits, including models of all kinds of structures; the machine shop is roomy and very well equipped and the university library contains 25,000 volumes. From examination papers in "The Engineer" the questions given students seem to be quite on a par with those put to American and European students under similar conditions.

THE CONGRESSIONAL LIBRARY, according to the first annual report ever made, now contains 787,715 volumes and 218,340 pamphlets. The daily average of books in the hands of readers is 3,000. For the year ending July 1, 1897, the amount received for copyright fees was $55,376. The total expense of operating the library, including $54,620 for salaries, was $61,604.26.

PORTRAITS OF THE 14 CHIEFS OF ENGINEERS, U. S. A., have been collected by Gen. Wilson, the present Chief of Engineers. The corps was organized March 16, 1802, and Gen. Jonathan Williams, Col. Joseph G. Swift, Col. W. K. Armistead and Gen. Alex. Macon were the first four incumbents. Gen. Joseph G. Totten was Chief for 26 years, from 1838 to 1864, and Gen. A. A. Humphreys had the next longest service of 13 years, from 1866. Gen. Williams and Col. Charles Gratiot each held office for ten years.

BOOK REVIEWS.

HANDBOOK OF STREET RAILROAD LOCATION.—By John P. Brooks, Professor of Civil Engineering in State College of Kentucky. New York: John Wiley & Sons. 6¾ × 4¾ ins.; morocco; pocket-book form; pp. 145; diagrams, etc.; $1.50.

In this handbook Prof. Brooks proposes to do for the engineer of street railways what Henck and others did for ordinary railway location. It is designed for both engineers and students, but it is intended for the engineer in charge of roadway and track construction, and has practically nothing to do with the mechanical or electrical part of street railway work. The first and larger portion is devoted to the trigonometrical problems involved in laying down a street railway; putting in and shifting its curves, and explaining the intricacies of turnouts, sidings, cross-overs, transition curves, etc. Earthwork computation is touched upon, and estimates of cost and details of construction are referred to somewhat too briefly we think. Trigonometrical formulas and the usual tables complete the handbook. This book is primarily intended for students. It is therefore only fair to say that it is useful in location only; and is not intended as a treatise upon the best practice in construction work.

HIGH MASONRY DAMS.—By E. Sherman Gould, M. Am. Soc. C. E., Consulting Engineer for Water-Works. Author of "A Primer of the Calculus," "Arithmetic of the Steam Engine," etc. Van Nostrand Science Series, No. 22. D. Van Nostrand Co. Boards; 6 × 3¾ ins.; pp. 88; 50 cts.

This volume replaces the original No. 22 in the Science Series, bearing the same title and written by Mr. John B. McMaster. The mathematical discussion of high masonry dams, which formed the bulk of Mr. McMaster's work, has been superseded by the much more extended and up-to-date treatise of Mr. Edward Wegmann. Mr. Gould, therefore, takes advantage of all the mathematical research of his predecessors by summing up as the average result of all their investigation a "section of equal resistance," in which the basis is a right-angled triangle having a base equal to two-thirds or three-fourths of its height. He then modifies this section according to certain practical conditions, and clearly, but briefly, discusses static and unit stresses and unequally distributed unit stress. The vertical section of high masonry dams is explained, chiefly by a numerical example, and with little mathematics; and the book closes with some good general advice upon the construction of high masonry dams and their accessories.

MECHANICAL DRAFT.—A Practical Treatise. B. F. Sturtevant Co., Jamaica Plain, Boston, Mass. 8vo.; cloth; pp. 385; 100 illustrations.

While this book is issued, presumably, chiefly to advertise the application of Sturtevant fan blowers to forced and induced draft apparatus, it is at the same time the most complete and extensive treatise on the subject of mechanical draft of which we have any knowledge. The first half of the book has nothing to say about fans nor about any means of producing draft, other than chimneys, but is an excellent compilation of data and tables, useful to steam engineers, concerning water, steam, combustion, fuel, efficiency of boilers, theory and practice of chimneys, etc. The advantages of mechanical draft, both forced and induced, are then considered at length, followed by the theory and practice of fans, construction and operation, and by a great number of illustrations of applications of mechanical draft in both land and marine practice. The book is handsomely printed and illustrated, and is well worth a place in every mechanical engineering library. The Sturtevant company deserves great credit for its enterprise and its broad-gage policy in thus making public the results of its large experience in this important field.

STEAM BOILERS.—By George Halliday, Whitworth Scholar; Head Master of Science Schools, East Ham. Lecturer in Engineering, Etc., Etc. Arnold's Practical Science Manuals; Prof. R. Meldola, General Editor. Edward Arnold, London and New York. Cloth; 12mo; pp. 392; $2.50.

This book was prepared, according to the editor's preface:

to meet the existing transitorial state of technical instruction in this country (England) when students, having gone into some branch of technology without adequate scientific preparation, endeavor to meet this deficiency by attending evening classes or continuation schools, where the sciences connected with their industry are taught.

The author's preface says:

The book has been written with the intention of guiding the student and workman into the habit of digesting the results of experiments and trials of boilers as given in the technical press. The book makes no pretence to be an end in itself. It will have served its purpose when it introduces its readers to the study of the construction and improvement of steam boilers as set forth from week to week in the columns of "The Engineer," "Engineering," and other journals.

The book, whose pretensions are thus modestly set forth, is an indifferent compilation of useful facts concerning steam boilers, together with some opinions of the author, which are frequently in error, and which show that he is not an expert on the subject of boilers, but only a compiler. He has written the book at the suggestion of Prof. Meldola, "as one of a series of manuals intended for students and workmen." It is to be hoped that Prof. Meldola will choose more capable authors for the remaining volumes of the series. The book contains a good deal of valuable information concerning boilers, but all of it may be obtained from other works on the subject. We quote a few extracts to show the author's style:

Heat is motion. It is a mode of motion. It is vibration. The vibration is heat. Nothing is at rest. It is heat which makes everything move. Heat is the motion, the motion is heat.

The ether is perfectly elastic. It carries the heat of the sun to the earth. Heat is like light only it has different wave-lengths. The sun as a source sets all the ether round it vibrating, and these vibrations come down to the earth, are transmitted outside and inside bodies, and penetrate wherever ether is, and ether is everywhere. And the result is that the ether, vibrating by the heat of the sun, sets all the particles of bodies vibrating more rapidly than they did before.

All of this is interesting as a sample of speculative natural philosophy, but what has it to do with steam boilers?

There are enormous quantities of carbon free in coal. The more free carbon there is in coal the better the quality of the coal. All the carbon in coal is not free carbon. Some of the carbon in the coal is in combination with hydrogen. Compounds of carbon and hydrogen are called hydrocarbons.

The author here seems to be ignorant of the fact that the hydrocarbons are more valuable as fuel than free carbon, and that a semi-bituminous coal containing 20% of hydrocarbons is a better quality of coal than an anthracite in which the carbon is practically all free carbon.

It mostly happens that the oxygen present (in coal) is not there in exactly the proportion required by the hydrogen present. Sometimes there is more oxygen than is required for the hydrogen.

If this is true it is a pity that the author did not give an analysis showing it. We have never seen such an analysis. Describing the arrangement of tubes in a horizontal tubular boiler, the author says:

Neither must they be set in vertical rows, for then the water rising from the upper surface of one row would rise and cling to that above, and they must not be fixed in zigzag because that prevents cleaning.

As the almost universal practice now in the United States is to arrange the tubes in horizontal tubular boilers in vertical rows, the above quotation is interesting.

On page 55 the author uses the word "calories" in the sense of British thermal units, the Fahrenheit scale being used. Most engineering writers agree in using the word "calories" only in connection with the Centigrade thermometer scale. Concerning chimney drafts the author gives Rankine's well-known theoretical treatment, which results in the following statement:

To insure the best possible draft through a given chimney, the temperature of the hot gas in the chimney should be nearly but not quite sufficient to melt lead.

The author does not state, as he should, that the words best possible draft are to be interpreted as meaning the maximum volume or quantity of gas discharged, and by no means as meaning the best or maximum pressure or force of draft. By omitting this explanation the author only perpetuates the confusion in the minds of students to which Rankine's discussion usually gives rise.

The chapter on "Theory of Water-Tube Boilers is one of the most entertaining in the book. We quote from it as follows:

Circulation is considered the chief good and to be gained at any cost. It is now thought that steam is not formed by circulation, and, when formed, is much injured in quality by the circulation. Circulation in itself is an evil. . . . Circulation must not trouble itself in moving the water rapidly about, but only in moving it as little as possible about, just enough to keep the water always in contact with the hot plate.

The author acknowledges that he absorbed what he knows, or rather doesn't know, of the above subject from the discussion concerning it in the columns of "The Engineer." Some of our readers may remember that that journal went very much astray upon this subject a few years ago, and misled a good many engineers on both sides of the water by its errors. It is a pity to see such stuff put into a book which is especially intended for students and workmen, who are unable to sift the true from the false.

ANNUAL REPORT OF THE STATE ENGINEER AND SURVEYOR OF THE STATE OF NEW YORK for the Fiscal Year Ending Sept. 30, 1896. Albany: State Printer. Cloth; 9 × 5¾ ins.; pp. 863; maps, plans and half-toned engravings.

This annual report of State Engineer Campbell W. Adams is an unusually interesting document and covers a wide range of subjects relating to the engineering work under state control. In connection with the so-called "nine million-dollar canal improvement" now in progress, Mr. Adams says that this practically contemplates the deepening of the Champlain Canal from 5 or 6 ft. to a uniform depth of 7 ft. and the deepening of the Erie and Oswego canals from 7 to 9 ft.—"except over and across aqueducts, miter sills, culverts and other permanent structures, where the depth shall be at least 8 ft." While this improvement will meet present demands on the Champlain Canal and possibly on the Oswego Canal, Mr. Adams says that it will not suffice for the Erie Canal. For the latter it simply means a possible additional 50 tons to the present paying load of 250 tons, a possible maximum increase of 20% in paying cargo, and means that two boats can pass each lock without disconnecting. He thinks that the scope of the proposed improvement should be enlarged. Nine feet of water throughout the canal, and not simply between structures, would add 50 tons more to the paying cargo, and as 28 locks are to be rebuilt anyhow, the cost of fixing the others would be comparatively small. He would also make these locks long enough to pass two 115-ft. boats instead of two 98-ft. boats, as now proposed; and he believes that this could be done, at a cost of about $8,000 per lock, by modifying the form of the gates. The additional length of boat would result in a gain of 17% in paying cargo, and with the additional draft proposed, it would be possible to carry a paying load of 410 tons; an increase of 64%, as compared with 300 tons, or an increase of 20% under the plan now authorized.

Mr. Adams urges the repeal of the law which limits the capital stock of canal transportation companies to $50,000. This law makes the interests of a few hundred boatmen superior to that of the state as a whole, and seriously interferes with the plans of those who aim to largely increase the traffic on the canal by conducting business on modern methods.

The detail of work proposed and in progress on the Erie improvement is then given, and the State Engineer, in discussing the lengthening of locks and the projects for mechanical lift locks, approves of the latter. To lengthen the 16 locks at Cohoes and improve the levels between them, would cost $1,686,831. A steel aqueduct, starting at the head of Lock 18, and ending in a mechanical lifting lock, accommodating two boats and making the 140 ft. in one lift, would cost about two-thirds of this sum. The latter plan would also largely save in water required and would effect an annual saving of $35,000 in lock tending alone. A mechanical lifting lock is also proposed for the five existing locks at Lockport, and they are being considered for several smaller lifts, from plans prepared by Mr. Chauncey N. Dutton, C. E.

A large part of the report is devoted to the Genesee storage surveys and investigation made by Mr. George W. Rafter, M. Am. Soc. C. E., the engineer in charge. Mr. Rafter also reports upon water storage in the upper Hudson valley and on the water supply of the Western Division of the Erie Canal. These reports are given in great detail, and the Genesee report includes much interesting matter relating to foreign high masonry dams.

For the topographic survey of the State of New York only $10,000 was appropriated in 1896. Prior to 1896, 10,120 sq. miles of the area of the state were mapped by the U. S. Geological Survey, working in co-operation with the State Engineer's force; in the last season 2,570 sq. miles were added, making 12,700 sq. miles now mapped; at a total cost to the state of $135,000, or $10.32 per sq. mile. Of the total state area about 36,000 sq. miles still remains to be surveyed; and Mr. Adams thinks it would be wise to appropriate $25,000 to $30,000 per annum for the next seven years and thus complete an important and valuable work.

The discussion by Mr. Rafter of the relation of forestry to stream flow, which was briefly abstracted in our issue of Jan. 6 will be found in full in this report.

We advise every one of our readers interested in hydraulic engineering to try and secure a copy of this report, and the custodians of the libraries of engineering societies and engineering schools should lose no time in forwarding their applications for it, which should be addressed, we presume, to Mr. Campbell W. Adams, State Engineer, Albany, N. Y.